DRAFT SYSTEM
TECHNICAL REQUIREMENTS DOCUMENT

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)
PROGRAM DEFINITION AND RISK REDUCTION PROGRAM

18 February 1997

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TECHNICAL REQUIREMENTS DOCUMENT FOR THE NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

CONTRACT NO.

PREPARED FOR:
NPOESS - INTEGRATED PROGRAM OFFICE
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Date____________________ Date__________________

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1. SCOPE

1.1 IDENTIFICATION

This Technical Requirements Document sets forth the requirements of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and is hereinafter referred to as the System.

1.2 SYSTEM OVERVIEW

The purpose of the System is to collect global multispectral radiometry and other specialized meteorological, oceanographic, and solar-geophysical data and to disseminate these data to the system's central users and field users deployed worldwide. These data are processed and delivered to the users in the form of Raw Data Records (RDRs), Sensor Data Records (SDRs), and Environmental Data Records (EDRs).

1.3 DOCUMENT OVERVIEW

This document contains all performance and support requirements for the System. In addition, all inter-segment and external interfaces are defined for the System. To avoid duplication, requirements that normally would appear in both 3.2 System Characteristics and 3.7 Segment Characteristics are only stated in section 3.7.

The documentation listed in section 2.0 follows an approach of minimum specs and standards. It is expected to be the basis of a system specification to be proposed by the contractor. The contractor may add to or revise the documents listed in section 2.0 with approval from the government.

The term *"TBD"* applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term *"TBS"* means that the government will clarify or supply the missing information in the course of the contract. The term *"TBR"* means that the requirement may be reviewed for appropriateness by the contractor or the government and may be changed by the government in the course of the contract.

Appendix A contains a definition of the terms used throughout the document. Appendix B contains the NPOESS survivability requirements which are classified and available in the NPOESS contractor libraries. Appendix C contains SDR/TDR requirements including potential sounder/imager frequency ranges that will be displayed as SDR/TDR imagery for operational weather forecasting. Appendix D contains the specific EDR requirements. Appendix E contains the RDRs and EDRs required for each Central and Field Terminal (*TBR*). Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes additional NPOESS mission needs which have potentially restrictive technical or programmatic uncertainties and which are beyond the current NPOESS baseline requirements.

1.3.1 Precedence

1.3.1.1 Requirement Weighting Factors

The requirements stated in this specification are not of equal importance or weight. The weighting factors that are incorporated in this specification are specified below.

a. ***Shall*** designates the most important weighting level; i.e. mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.

b. **S*hould*** designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the *should* requirements does not require approval of the contracting officer.

c. ***Will*** designates the lowest weighting level. These *will* requirements designate the intent of the government and are often stated as examples of acceptable designs, items and practices. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

1.3.1.2 Conflicts

TRD 1.3.1.2-1
In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification should be considered the superseding requirements, unless the conflict involves external interface requirements of the System.

TRD1.3.1.2-2
In the event of a conflict involving the external interface requirements of the System, such as a conflict with equipment external to the System being specified, or in the event of any other unresolved conflict, such as a conflict with government-furnished property, the contracting officer should be notified, and the order of precedence should be as directed by the contracting officer.

1.4 SYSTEM CLASSIFICATIONS

The operational capability of this System is to be implemented incrementally such that the System can transition without major disruption through the following baseline classifications:

a. IOC System (initial operational capability system)
b. FOC System (final operational capability system)

The requirements stated in this document that are not identified as applying to a specific system classification apply to all of the system classifications. Requirements stated as applying to the initial operational capability system also apply to the final operational capability system, unless stated otherwise in the text.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this TRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is *(TBR)*.

SPECIFICATIONS:

Military

DOD-E-83578A	Explosive Ordnance for Space Vehicles, General Specification for
Mil-A-83577B	Moving Mechanical Assemblies

STANDARDS:

Military

DOD 5200.28-STD Dec 85	Department of Defense Trusted Computer System Evaluation Criteria
MIL-STD-461D	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-1540C	Test Requirements for Space Vehicles
MIL-STD-1541A	Electromagnetic Compatibility Requirements for Space Systems
MIL-STD-1546B	Parts, Materials and Processes Control Program for Space and Launch Vehicles

Regulations

AFM-91-201 7 Oct 94	Explosives Safety Standards
EWR 127-1 31 Mar 95	Eastern and Western Range Safety Requirements
USSPACECOM Reg 57-2, 6 Jun 91	Minimization and Mitigation of Space Debris

Other

ESD-TR-91-212 October 1991	TAF Unit-Level Open System Architecture(ULOSA)Specifications
Feb 95	SARSAT S&R Repeater (SARR)

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specified acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 NONGOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this TRD to the Extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is *(TBR)*.

STANDARDS:

ANSI/ISO/TEC 8652 1995	Ada-95 (If Ada is used, then this standard is applicable.)
CCSDS 701.0 ONB-1 Dec 1987 CCSDS-SCPS (TBS)	Advanced Orbiting Systems, Network and Data Links: Architectural Specifications or CCSDS-SCPS
National Aerospace Standard 411 Rev 2, 29 Apr 94	Hazardous Materials Management Program
POSIX	Software Operating System Standards (If POSIX is used, then this standard is applicable.)
ISO 9001	Quality Program Requirements

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because they have been referred to in various parts of the TRD.

SPECIFICATIONS:

<u>Military</u>

AF TM- 86-01	Technical Manual Contract Requirements

STANDARDS:

MIL-STD-129K 1 Jun 88 Notice 1 15 Sep 89	Marking for Shipment and Storage

MIL-STD-490A 4 June 1985	Specification Practices
MIL-STD-882c MIL-STD-498 5 Dec 1994	System Safety Program Requirements Software Development and Documentation
MIL-STD-1246C 11 April 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1472D 14 Mar 89	Human Engineering Criteria for Military Systems, Equipment and Facilities
MIL-STD-1522A	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL-STD-1542B	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543B	Reliability Program Requirements for Space and Missile Systems
MIL-STD-1547B	Parts and Materials Program for Space and Launch Vehicles
MIL-STD-1809	(USAF): Space Environments for USAF Space Vehicles
Department of CommerceSeptember 1995 Edition	National Telecommunications and Information Administration "Manual of Regulations and Procedures for Federal Radio Frequency Management"

NOAA

S24.801 2 Dec 88	Preparation of Operations and Maintenance Manuals
S24.806 30 Apr 87	Software Development, Maintenance, and User Documentation
S24.809 1 Dec 89	Grounding Standards

NASA

SP-R-0 022A (JSC) 9 Sept 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application
NASA Tech Memo 100471	Man-made Orbital Debris-Handbook of Geophysics and Space Environments

NASA SP-8031	Meteoroids
March 1995 Up dated May 1996	Preferred Parts List PPL-21, Goddard Space Flight Center

OTHER PUBLICATIONS:

Handbooks

MIL-HDBK-263B 31 July 94	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts. Assemblies and Equipment (Excluding Electrically initiated Explosive Devices) (Metric)
FMH-1B	Federal Meteorological Handbook 1B
MIL-HDBK-340 1 July 1985	Application Guidelines for MIL-STD-1540B: Test Requirements for Space Vehicles
MIL-I-46058	
	Handbook of Geophysics and Space Environments

Other

NACSEM 5112(S) Apr 75	Non Stop Evaluation Techniques (U)
2 Nov 89	National Space Policy Directive 1
NSTISSI 7000(S/NF) 17 Oct 88	TEMPEST Countermeasures for U.S. Facilities (U)
1 Jul 1988	SARSAT agreement, for search and rescue (i.e., emergency transmitter locations).
4 Aug 1995	Air Force Satellite Control Network (AFSCN) Operational Requirements Document (ORD)
NAIC-1571-0110-96(S) Mar 96	Defense Meteorological Satellite Program (DMSP)/National Polar-Orbiting Operational Satellite System (NPOESS) System Threat Assessment Report (STAR)
NAIC-1571-727-95 (S/NF/FRD) 11 Sep 1995	Space Systems Threat Environment Description (TED)
2 Aug 1995	Training System Requirements Analysis Book

(Technical society and technical association specifications and standards generally are available from reference libraries. They also are distributed among technical groups and using federal agencies. The contracting officer should be contacted regarding the availability of any referenced document not readily available from other sources.)

3. SYSTEM REQUIREMENTS

3.1 DEFINITION

3.1.1 System Description

The NPOESS is a System of polar orbiting weather satellites and ground equipment used for the collection, analysis, and dissemination of weather data to government and civilian users. The System shares data with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The role of EUMETSAT Meteorological Operational Program (METOP) in NPOESS is *(TBS)* pending an international agreement between the United States Government (USG) and the European Space Agency (ESA).

3.1.2 System Segments

The System has four system segments:

a. Space Segment (SS)
b. Command, Control, and Communications Segment (C3S)
c. Interface Data Processor Segment (IDPS)
d. Launch Support Segment (LSS)

3.1.2.1 Space Segment (SS) Description

The SS consists of satellites and ground support equipment. The satellites collect global multispectral data on clouds and other meteorological, oceanographic, climatological, and solar-geophysical parameters. The satellites also carry surface data collection (SDC) sensors (e.g., Argos or its follow-on) and search and rescue (S&R) sensors (e.g. Search and Rescue Satellite Aided Tracking (SARSAT)). The satellites store and downlink all data (except S&R) to ground stations, possibly through data relay satellites, and provide a continuous real-time downlink for receipt of data by field terminals within view of the satellite.

3.1.2.2 Command, Control and Communications (C3) Segment Description

The C3S consists of shared and dedicated resources: ground stations which provide ground to space connectivity, primary and backup satellite operations centers, communication elements, and flight vehicle simulators. The C3 functions include Mission Planning, Antenna Resource Scheduling, Satellite Operations, Anomaly Resolution, System Security, Relay of Data to Central Users, and Spacecraft and Sensor Engineering support of activities such as launch and early-orbit checkout.

3.1.2.2.1 Ground Station Element

Ground stations provide ground to space connectivity for the C3S. They are shared assets and may include NOAA's Command and Data Acquisition (CDA) ground stations at Fairbanks, Alaska, and Wallops Island, Virginia, as well as the AFSCN Remote Tracking Stations (RTS) located at Thule, Greenland; Oakhanger, England; and others (*TBD)*. The European CDA station at Kiruna, Sweden or Tromso, Norway may be utilized to augment capabilities, but NPOESS requirements are to be met without that augmentation *(TBS)*. NPOESS equipment at a ground station form an element of the C3S. Other ground stations (e.g., Antarctica station or NASA's Tracking and Data Relay Satellite System (TDRSS) stations) may be considered to improve timeliness.

3.1.2.2.2 Satellite Operations Center (SOC)

The primary SOC will be located at Suitland, MD (SOCC) and the backup (ESOC) at Falcon AFB, CO. The primary SOC will be responsible for performing the operational functions of satellite command and control, mission planning, antenna resource scheduling, launch and early orbit support, anomaly resolution, telemetry data processing, and the support of data delivery to users . The backup SOC will be capable of performing the same operational functions as the primary SOC, with the exception that launch and early orbit operations will only be done from the primary SOC.

3.1.2.2.3 Data Routing and Retrieval (DRR)

The DRR will provide all inter-segment communications for the C3S and IDPS. Inter-segment communications include the routing of stored mission data to the IDPS Central element and all telemetry (stored and real-time) data to the SOCs in support of System data availability requirements. (DRR does not provide space-ground communications) The DRR will provide routing for commands, and any other communications between the SOCs, Ground stations, Flight Vehicle Simulators (FVS), and IDPS elements.

3.1.2.2.4 Flight Vehicle Simulator (FVS)

The FVS element will provide high fidelity simulation of the on-orbit spacecraft and sensors. An operator console will monitor and control the health and welfare of simulated satellites.

3.1.2.3 Interface Data Processor Segment (IDPS) Description

The IDPS consists of ground hardware and software elements which ingest and store (temporarily) the Raw Data Records (RDRs) and process them, as necessary, into Sensor Data Records (SDRs) and Environmental Data Records (EDRs) at Centrals and at DoD Field Terminals. The currently defined Centrals are AFGWC, NOAA/NESDIS, FNMOC, NAVOCEANO, and 50 WS. Field Terminals may be land or ship-based, fixed or mobile, and they may receive real-time mission data directly downlinked from the spacecraft. The NOAA/NESDIS IDPS will receive and store (temporarily) RDRs, and make available in unprocessed form to NOAA/NESDIS data processing facilities.

3.1.2.4 Launch Support Segment (LSS) Description

The LSS will provide resources to accomplish launch operations, and to place each satellite into the correct orbit. The LSS includes all launch support equipment including Aerospace Ground Equipment (AGE), Real Property Installed Equipment (RPIE) and launch facilities. AGE consists of test equipment, computer check-out systems, etc. RPIE includes items such as power equipment, air conditioning equipment, and non-flight fuel stores. The launch facilities include payload test facilities and other required equipment/facilities to support ground operations for testing the satellite following integration onto the launch vehicle. A listing of launch site processing facilities for pre-launch checkout and servicing of the satellite is *(TBR)*.

3.1.3 A Specification Tree.

The specification tree for the System is shown in Figure 3-1 (*TBS*).

SPECIFICATION TREE

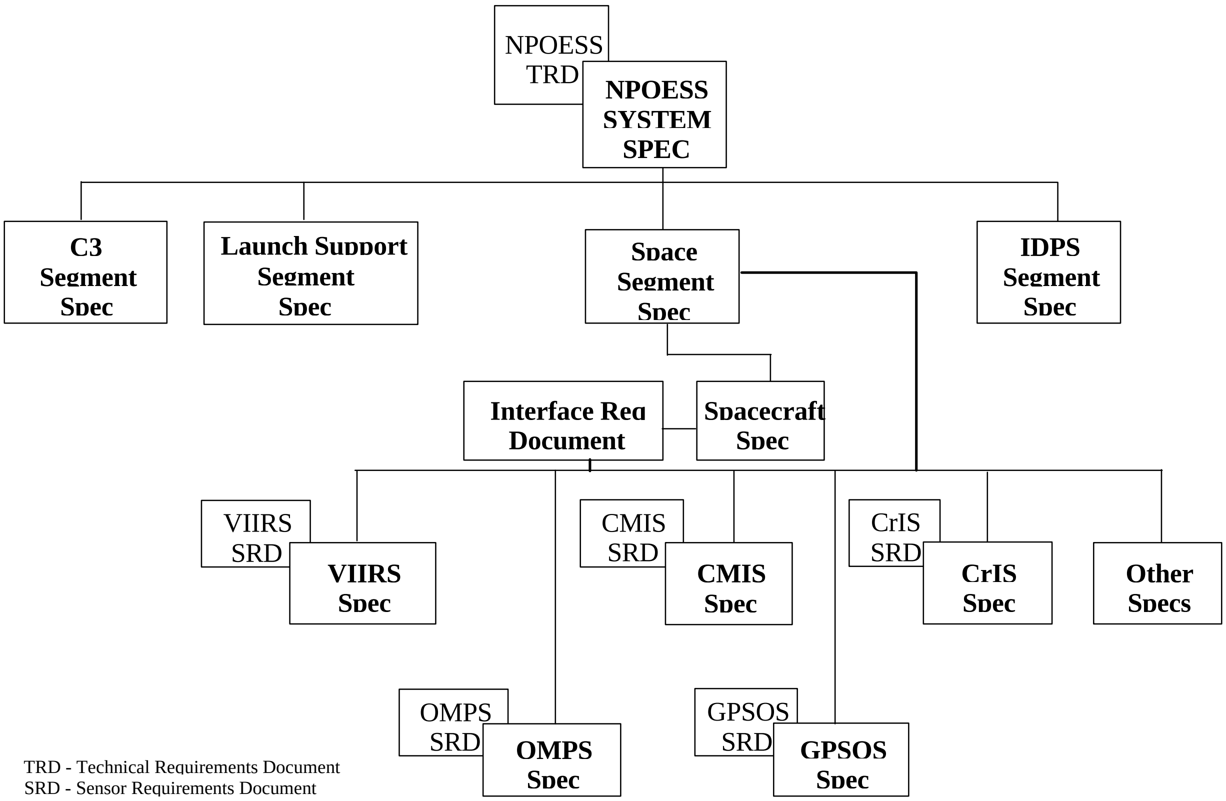


Figure 3-1 System Specification Tree (*TBS*).

3.1.4 Top-Level System Functions *(TBS)*

3.1.5 System Modes

In addition to operations modethere are two othermodes for which special attention is required: Safe and Autonomous Mode. Special requirements associated with these modes are described in section 3.7.1.2, Satellite Requirements, and section 3.2.1.3, Autonomous ModeCapability, respectively.

3.1.6 Operational and Organizational Concept

3.1.6.1 Expendable Launch Vehicle Concept

Each satellite will be launched using an expendable launch vehicle with a goal of direct insertion into the operational orbit. The NPOESS baseline is planned to be medium class launch vehicle, most likely a Delta class equivalent.shall not exceed a “medium class” capability such at the Delta 2.

3.1.6.2 Launch Operations Concept

3.1.6.2.1 Pre Launch

The satellite will be transported directly to the launch base where final vehicle preparations and checkout will be accomplished. Final inter-segment and launch system verification tests will be accomplished prior to launch.

3.1.6.2.2 Launch and Injection

During launch and injection to the operational orbit, the various spacecraft subsystems may be powered on or turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection. Transmission of launch vehicle telemetry may satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations would be used to the extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments would be initiated by memory command. Early orbit check-out will be conducted at the NPOESS primary SOC in Suitland, MD.

3.1.6.3 On-orbit Operational Concept

3.1.6.3.1 On-orbit Tests

The initial on-orbit period is devoted to a complete spacecraft checkout and the calibration and performance verifications of the sensor(s). The spacecraft and sensor performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.6.3.2 Initial and Final Operational Capabilities

The System initial operational capability (IOC) will be met when: TIROS N' (with NPOESS modification sensors) and the first NPOESS satellite are operational; sufficient C3 and mission data recovery resources are available to allow all mission data to be processed at all centrals and 50 percent of the field terminals; sufficient crews are trained to allow 24 hours/day, 365 days/year operations at the primary SOC, and to allow backup operations as needed; sufficient sustaining engineering resources are in place to allow for anomaly resolution, for example; sufficient logistics resources are in place to support C3, data recovery, and the IDPS; and approval to operate at Falcon AFB is received. The System final operational capability (FOC) will be met when: a full NPOESS satellite constellation meeting all contractual system requirements is operational; sufficient C3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C3S, data recovery, and IDPS operations; and approval to operate at Falcon AFB is received.

3.1.6.3.3 On-orbit Operations

3.1.6.3.3.1 Space Segment

The satellites continuously perform required measurements using the on-board sensors and support the SDC and S&R sensors. Real-time data are continuously broadcast so that users within the field of view may receive the data. The satellites receive commands from the ground for either execution in real time or for subsequent on-board execution.

3.1.6.3.3.2 C3 Segment

The C3S will route data to the Centrals' IDP. The C3S should be able to also receive and route data from an NPOESS-dedicated EUMETSAT METOP (*TBS*) and route NPOESS data received by METOP ground stations. Routing of NPOESS data to EUMETSAT facilities is *(TBS)***.**

Satellite Control Authority (SCA) is the authority to direct, approve, or delegate satellite command and control. This authority will reside with the primary SOC, located in Suitland, Maryland. The backup SOC, located at Falcon AFB, Colorado and operated by the USAF, will assume SCA in the event of a failure at the primary SOC, or during any other scenario as directed by the IPO (e.g., preventive maintenance activities).

3.1.6.3.3.2.1 Ground Stations

The ground stations will provide the space-to-ground connectivity for the System. Mission data, as well as stored and real-time telemetry data will be downlinked to the ground stations from the satellite. The downlinked data will be stored at the ground stations as well as relayed to the data routing and retrieval element for distribution. The ground stations will also provide the capability for uplink commanding.

3.1.6.3.3.3 IDP Segment

Elements of the IDP segment will receive RDRs and process them as appropriate for their missions into EDRs. The IDP segment may also use ancillary data in the processing. Processing RDRs into EDRs will require production of intermediate-level satellite sensor data files, commonly known as Sensor Data Records (SDRs) and Temperature Data Records (TDRs). SDRs/TDRs associated with imagery and sounding EDRs are used for near term display and for retrospective processing, leading to improved methods, or for archival, for long-term sensor evaluation or troubleshooting. This intermediate-level needs to be available as separate and selectable data records. This data is vital when validating the data, determining data quality, and in data quality resolution. See Appendix A for definition of terms.

3.1.7 Missions

The mission of the System is to provide an enduring and survivable capability which supports user requirements through all levels of conflict consistent with the survivability of the supported forces, to collect and disseminate global meteorological, oceanographic, and solar-geophysical data required to support worldwide DoD and civilian operations and high-priority programs. An auxiliary mission is to provide S&R capabilities.

3.1.8 Threat

The System is subject to the threat described in Section 6.

3.2 SYSTEM CHARACTERISTICS

Requirements that are known to be applicable only to a single segment or to a single prime Configuration Item (CI), such as the spacecraft, are stated in the appropriate paragraph in Subsection 3.7 and not in this subsection.

3.2.1 Performance Characteristics

3.2.1.1 Performance Requirements for Each System Mode

In additional to Operational mode, there are two modes for which special attention is required: Safe mode and Autonomous mode. These modes and the special requirements associated with them are described in section 3.7.1.2., Satellite Requirements, and section 3.2.1.3 Autonomous mode Capability, respectively.

In Operational Mode, the System will provide RDRs, SDRs, and EDRs to the users.

3.2.1.1-1
The satellite shall be able to speartely commend any sensor suite into any sensor mode.

3.2.1.1.1 EDR Requirements

TRD3.2.1.1.1-1
The environmental data records shall meet, as a minimum, the EDR threshold requirements specified in Appendix D.

3.2.1.1.2 RDR Requirements

Since RDRs are processed into EDRs, RDRs are considered to have met their requirements when they are of an appropriate format and quality to be adequately processed into their associated EDRs.

3.2.1.1.3 SDR/TDR Requirements

Processing RDRs into EDRs requires production of intermediate-level satellite sensor data files, commonly known as Sensor Data Records (SDRs) and Temperature Data Records (TDRs). The requirement for the SDRs/TDRs is for retrospective processing, leading to improved methods, or for archival, for long-term sensor evaluation or troubleshooting. Throughout this document, production of EDRs will necessarily also mean production of SDRs/TDRs, as needed. This includes the EDR/RDR matrix (Appendix E), which lists delivery destinations of RDRs/EDRs.

3.2.1.1.4 Earth Location Requirements

TRD3.2. 1.1.4-1
The IDPS shall earth locate sensor data in geodetic latitude and longitude corrected for altitude within the accuracy specified for each EDR in Appendix D.

3.2.1.2 Data Availability

3.2.1.2.1 Data Availability to the Centrals

The percentage of time for preemption of NPOESS data downlink by a higher priority mission in a system that utilizes government resources is *(TBR).*

TRD3.2.1.2.1-1
The mission data shall be provided to the Centrals as shown in Appendix E.

TRD3.2.1.2.1-2
The mission data acquired and stored by a satellite shall be downloaded via the C3S at least once per orbit.

TRD3.2.1.2.1-3
Direct downlink of stored data from the satellite is not required at the centrals, however a minimum of two Centrals shall receive all the stored data via the C3S in order to provide for backup and contingencies. This requirement does not apply in the case of a real-time data relay solution (e.g. TDRSS) or for direct fiber optic links between ground stations and Centrals.

TRD3.2.1.2.1-4
Ninety-seven point five percent (97.5%) (on an annualized basis) of the observable data collected shall be provided to the Centrals.

TRD3.2.1.2.1-5
Ninety-five percent (95%) of the time, the elapsed time from the time of observation until all of the required EDRs have been processed at the Centrals shall be no greater than 1.25 times the length of an orbital period plus 30 minutes.

TRD3.2.1.2.1-6
In the case of a missed pass, the maximum elapsed time shall be no greater than 2.5 times the orbital period plus the 30 minute period mentioned above.

TRD3.2.1.2.1-7
Data (RDR to EDR) processing time at DoD Centrals shall not exceed 20 minutes. This 20 minute period shall be part of the 30 minute period described above.

TRD3.2.1.2.1-8
If a satellite contact is missed, data shall be stored and recovered on the next available contact.

TRD3.2.1.2.1-9
The spacecraft shall be able to store at least one-half of each orbit of data at the regional (high) resolution for those EDR parameters with a regional horizontal spatial resolutional (or cell size) specified in Appendix D.

TRD3.2.1.2.1-10

Specific areas for each orbit might not be contiguous, but shall be commandable.

TRD3.2.1.2.1-11
The spacecraft shall also be able to store at least a full orbit of data at global resolution.

3.2.1.2.1.1 NOAA/NESDIS

TRD3.2.1.2.1.1-1
NOAA/NESDIS shall receive the stored RDR data set from any NPOESS satellite within 15 minutes of loss of signal (LOS)*(TBR)* at any NPOESS C3 station. A RDR data set is defined as beginning at LOS from one C3 station to the next LOS of the next C3 station. (The RDR data set will then includeobservations being acquired by the NPOESS satellite during acquisition at any C3S station).

3.2.1.2.2 General Data Availability to Field Terminals

The Field Terminals are comprised of two types: high data rate and low data rate. For the DOD, AN/UMQ-13 (Mark IVB), AN/TMQ-35 (MARKIV), AN/TMQ-43 (enhanced Small Tactical Terminal (STT), STT JT-FST), stand-alone AN/SMQ-11, combination AN/SMQ-11 and AN/UMK-3 (TESS(3)), IMETS, AN/TMQ44 (Meteorological Mobil Facility) are high data rate terminals; and the Basic STT is a low data rate terminal. NPOESS should be designed to meet user needs with minimum impact to existing receiver terminals or planned follow-on terminals. NPOESS is not responsible for modifications to non-DoD field terminals. Lossy compression is allowed in both the high and low real time data rate links..

TRD3.2.1.2.2-1
Real-time mission data shall be provided directly to field users whenever the NPOESS satellite is within the field of view of the field terminal (*TBR)* degs above the horizon as a threshold; the horizon as a goal.

TRD3.2.1.2.2-2
The NPOESS system shall provide for modification of the DoD field terminals, if required, to receive and process the mission data from the NPOESS satellite with no degredation in existing capabilities.

3.2.1.2.3 High Data Rate DoD Terminals

TRD3.2.1.2.3-1
The high data rate Field Terminal IDPS shall receive the high resolution data stream containing the mission data as specified in Appendix E.

3.2.1.2.4 Low Data Rate DoD Terminals

TRD3.2.1.2.4-1
The low data rate Field Terminal IDPS shall receive the low data rate link (e.g. fewer channels at regionalresolution or all channels at reduced resolution) containing the mission data as specified in Appendix E.

3.2.1.3 Autonomous Mode Capability

Each satellite should be capable of performing housekeeping tasks without ground contact.

TRD3.2.1.3-1
The satellite shall have an autonomous mode capability which maintains the ability to provide real-time mission data with a mapping accuracy threshold of at least 45 km ($\leq$ 1 km objective) to DoD Field Terminals without C3 contact for a period of at least 21 days (60 days objective) providing that the satellite was operating normally prior to switching to autonomous mode.

TRD3.2.1.3-2
The System shall have the capability to automatically encrypt the links, except for the S&R and SDC real time downlinks, providing that the satellite was operating normally prior to switching to autonomous mode.

TRD3.2.1.3-3
Storing of sensor data and transfer of stored data to ground receivers may be affected, but real-time transmissions shall not be affected by autonomous mode.

TRD3.2.1.3-4
Each satellite shall automatically transition to autonomous operations after an SCA determined and table loaded (e.g. 24 hours default) period of time has elapsed from the time of reception of the last command from the C3S.

TRD3.2.1.3-5
Each satellite shall maintain a historical record of autonomous events to the extent necessary to enable reconstruction of the decisions made and methods used by the satellite while performing autonomous mode..

TRD3.2.1.3-6
Each satellite shall be commandable between normal operations and autonomousmode by reception of a correct ground command from the C3S.

TRD3.2.1.3-7
Ground control override by the C3S shall be provided for any autonomous function.

TRD3.2.1.3-8
When transition to autonomousmode occurs, satellites shall automatically begin transmission of data using procedures/methods (*TBD*) that can accomplish data denial.

TRD3.2.1.3-9
The spacecraft shall recover to normal operations within 5 minutes after reconfiguration commands from the ground.”

3.2.1.4 Orbit Adjustment Capability

TRD3.2.1.4-1
The System shall maintain a precise orbit altitude to +/- *(TBD)* km and nodal crossing times to +/- 10 minutes during normal operations throughout the mission lifetime.

TRD3.2.1.4-2
The System shall maintain an exact groundtrack repeat to +/-*(TBD)* km over *(TBD)* days.

TRD3.2.1.4-3
The System shall provide the same satellite functional capabilities after an orbit adjustment maneuver as were available prior to the maneuver if they cannot be maintained during the maneuver.

TRD3.2.1.4-4
Each NPOESS satellite shall be designed to prevent damage or contamination of on-board sensors and subsystems due to delta-V thrust applications during an orbit adjustment maneuver.

3.2.1.5 Surface Data Collection

TRD3.2.1.5-1
The SDC sensor, with the exception of the antennas, will be provided GFE, and shall be integrated, operated, and maintained.

TRD3.2.1.5-2
The System shall transmit SDC data in real-timefor reception by worldwide civilian field terminals.

TRD3.2.1.5-3
The System shall store SDC data for subsequent transmittal to Centrals.

TRD3.2.1.5-4

The System shall be capable of acquiring data from the uplinks of up to a total of 5600 (*TBR*) Platform Transmitter Terminals (PTTs) with up to 1660 (*TBR*) PTTs within each satellite's instantaneous field of view.

3.2.1.6 Search and Rescue Capability

TRD3.2.1.6-1
The S&R sensor, with the exception of the antennas, will be provided GFE and shall be integrated, operated, and maintained.

TRD3.2.1.6-2
Data from the S&R sensor will be downlinked to the S&R Mission Control Centers (MCCs) and Local User Terminals (LUTs) in real time.

3.2.1.7 Mission Planning Capability

TRD3.2.1.7-1
The System shall perform the mission planning required to prioritize user requests, schedule the required use of the ground station network, distribute mission, SDC, S&R, and telemetry data, provide pass plans to users, and coordinate mission events with European agencies, as required.

3.2.1.8 Mission Sensor Calibration

TRD3.2.1.8-1
The System shall perform periodic autonomous or ground controlled mission sensor calibration as required.

3.2.1.9 Data Access

Mission data access is a key parameter.

TRD3.2.1.9-1
Under normal conditions, NPOESS unencrypted mission data shall be accessible by users on a world-wide basis.

TRD3.2.1.9-2
The System shall have the capability to deny mission data and telemetry whenever any satellite is operating in the autonomous mode or upon ground command.

TRD3.2.1.9-3
The System shall always provide an unencrypted real-time SDC data downlink.

TRD3.2.1.9-4
The System shall always provide an unencrypted S&R data downlink.

TRD3.2.1.9-5
The System shall have the capability of encrypting uplinked commands and memory loads prior to transmission to the satellite.

TRD3.2.1.9-6
The spacecraft shall have the capability to decrypt and authenticate uplinked commands and verify memory loads after reception.

3.2.1.10 Real-time Data Downlink Transmission Capability

TRD3.2.1.10-1
NPOESS satellites shall have the capability to continuously downlink real-time mission data to field terminals at both a high data rate and a low data rate simultaneously.

TRD3.2.1.10-2

The high data rate link shall contain mission data at the same resolution as that for regional resolution provided to Centrals.

TRD3.2.1.10-3
The low data rate link shall contain fewer channels of mission data and/or a coarser resolution than the high data rate link.

3.2.1.10.1 Real-time Telemetry Downlink Transmission Capability

TRD3.2.1.10.1-1
NPOESS satellites shall have the capability to downlink real-time telemetry data when each satellite is in contact with a C3S ground station.

3.2.1.11 Stored Data Downlink Transmission Capability

TRD3.2.1.11-1
NPOESS satellites shall have the capability to downlink data that have been acquired and stored onboard the satellite to the C3 Segment when the satellite is in contact with a C3 Segment ground station.

TRD3.2.1.11-2
This downlink shall include mission data, SDC, and health and status telemetry data.

3.2.1.12 Data Time Synchronization

TRD3.2.1.12-1
All RDRs shall contain time reference information for data synchronization.

3.2.1.13 Data Formatting and Compression

TRD3.2.1.13-1
The System shall conform to the Consultive Committee for Space Data Systems (CCSDS) packetization per the *(TBS)* real-time interface specification and the *(TBS)* stored-data interface specification.

TRD3.2.1.13-2
If data compression techniques are used in stored data retrieval, the compression shall be lossless.

3.2.1.14 Command and Memory Loads Uplink Transmission

TRD3.2.1.14-1
The System shall have the capability of transmitting information to the satellite onboard processors. This information includes operational parameters, processor instructions (software) and sequencing states.

3.2.1.15 Satellite External and Built-in Testing

TRD3.2.1.15-1
The System shall have the capability of externally testing each satellite, while in storage and on the launch pad, to verify its performance and operational readiness. Components that must be cold to operate properly are not subject to external testing on the launch pad.

TRD3.2.1.15-2
Each satellite shall have the capability of accomplishing self-testing using built-in test (BIT) functions to determine its functionality, performance, and operational readiness.

3.2.2 System Capability Relationships

3.2.2.1 Reference Timelines

(TBS)

3.2.3 Interface Requirements

NPOESS external and internal interfaces are illustrated in Fig. 3.2.3-1.

3.2.3.1 External Interface Requirements

The following subparagraphs describe the requirements for interfaces between NPOESS and other systems.

3.2.3.1.1 External Interface to Central User

TRD3.2.3.1.1-1
The IDPS element shall interface with its host facility for floorspace, power, lighting, air-conditioning, security, and access to communications networks.

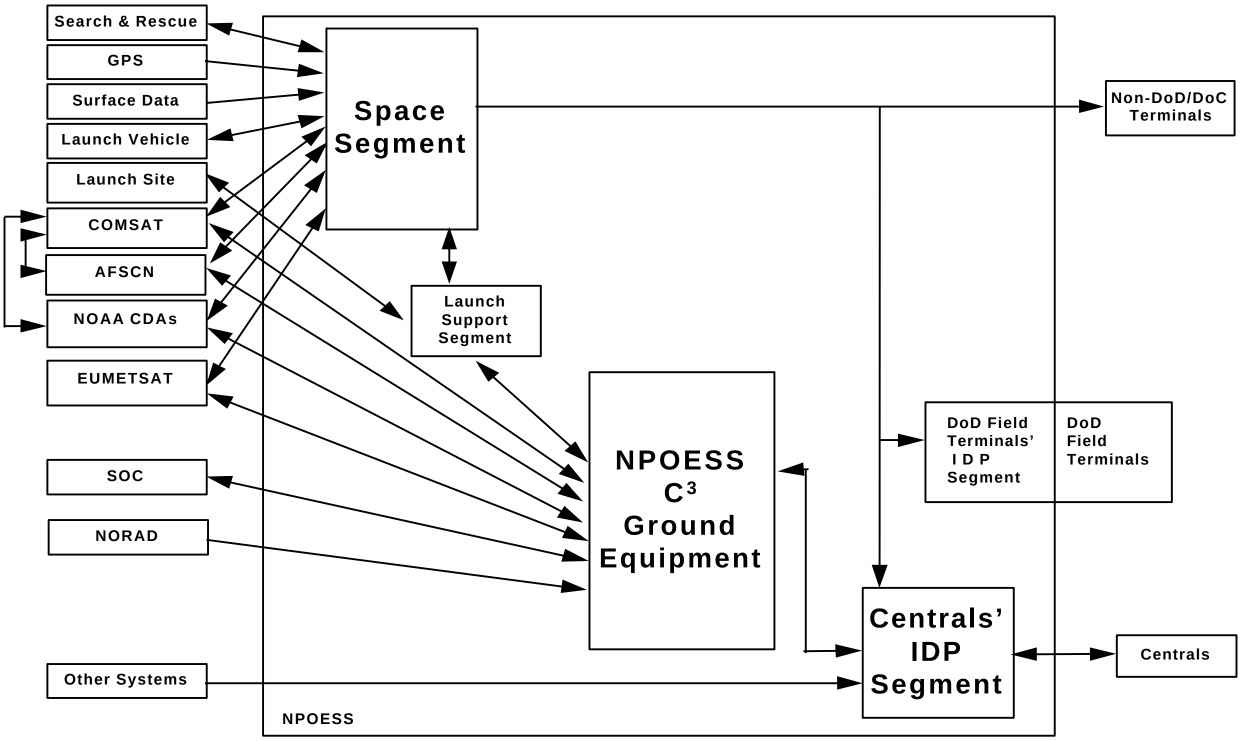
TRD3.2.3.1.1-2
Backup power sources shall be able to provide power for 24 hours (TBR).

TRD3.2.3.1.1-3
The IDPS element shall have the capability to provide RDRs, SDRs and EDRs to Centrals as specified in Appendix E.

TRD3.2.3.1.1-4
The IDPS element shall have the capability to respond to data requests from Centrals within 24 hours.

TRD3.2.3.1.1-5
The IDPS element shall have the capability to receive ancillary data as required to generate the EDRs specified in Appendix E *(TBS).*

TRD3.2.3.1.1.-6
The IDPS element shall have the capability to provide SDC data.



Note: Some external systems will contain NPOESS equipment. These systems may include the SOC, AFSCN, NOAA CDAs, Field Users, and METOP.

Figure 3.2.3-1. NPOESS External and Internal Interfaces

3.2.3.1.2 External Interface to DoD Field Terminal

The NPOESS Field Terminal external interfaces will consist of the interface between the NPOESS-modified DoD field terminal (receiver equipment and IDP) and the unmodified field terminal equipment and ancillary data received via the unmodified field terminal equipment.

TRD3.2.3.1.2-1
The IDPS field element shall provide the capability to deliver EDRs as specified in Appendix E to the Field User.

TRD3.2.3.1.2-2
The IDPS shall have the capability of receiving ancillary data as needed for EDR generation.

TRD3.2.3.1.2-3
The IDPS element shall have the capability to respond to data requests from field terminals for a period of time corresponding to their respective storage capabilities.

3.2.3.1.2.1 External *(TBR)* Interfaces to Receiver Equipment

TRD3.2.3.1.2.1-1
The IDPS field terminal element shall have the capability to receive real-time mission data from the field terminal receiver equipment.

3.2.3.1.3 External Interface to Non-DOD Field Terminals

TRD3.2.3.1.3-1
The Space Segment shall continuously downlink real-time mission data and SDC data to Non-DoD field terminals.

3.2.3.1.4 External Interface to Other Field Ternimals

(TBS)

3.2.3.1.5 External Interface to METOP Spacecraft

(TBR)

3.2.3.1.6 External Interface to Search and Rescue System

The NPOESS Space Segment will incorporate a S&R sensor which is provided GFE (with the exception of the antennas). The S&R sensor receives uplink signals at 121.5, 243.0, and 406.05 MHz from emergency location transmitters (ELT). The transmissions at 406.025 MHz are processed by the sensor's Search and Rescue Processor (SARP), which measures the frequency and extracts the transmitted message, then stores this information together with the time of reception in the SARP-M circular memory. This stored information is then retrieved in near real-time and formed into the SARP 2.4 kbps data stream. The SARP data stream is interleaved with the translated outputs from receivers at 121.5 and 243.0 MHz, and a separate receiver centered at 406.05 MHz, and downlinked in realtime at 1544.5 MHz to any S&R emergency location transmitter (LUT) within the satellite's field of view (see SARSAT S&R Repeater (SARR). Then these data are forwarded to the S&R Mission Control Centers. These centers distribute the data to the international search and rescue forces. The S&R system is part of the COSPAS-SARSAT international search and rescue system which is managed by representatives of the U.S., Canada, France, and Russia. The S&R ELTs and LUTs will be supplied, implemented, operated, and maintained by local authorities.

The NPOESS Program will be compatible with DOC's international agreements, COSPAS / SARSAT agreement, 1 Jul 1988) for search and rescue (i.e., emergency transmitter locations).

TRD3.2.3.1.6-1
The Space Segment shall be capable of receiving ELT data and downlinking the data at 1544.5 MHz to any S&R LUTs within the satellite's field of view. Data formats are (*TBS*).

TRD3.2.3.1.6-2
The Space Segment shall not alter the data that is transmitted between the S&R sensor and a S&R LUT to prevent interference or unauthorized contact.

3.2.3.1.7 External Interface to Surface Data Collection

The NPOESS Space Segment will incorporate a SDC sensor (e.g., Argos) which is provided GFE (with the exception of the antennas). The sensor receives randomly distributed uplink signals at 401.650MHz from Argos PTT deployed on a worldwide basis. The transmissions are processed by the sensor and downlinked over the satellite's SDC real-time data downlinks to any Argos Local User Terminals within the satellite's field of view. The stored Argos data is downlinked as part of the stored data downlink to the C3S for subsequent transmission via the central site at NOAA/NESDIS to the Argos processing centers in the U.S. and France. The Argos system is an international surface data collection system which is managed by France.

TRD3.2.3.1.7-1
The Space Segment shall be capable of receiving Argos (or follow-on) Platform data and downlinking the data in real-time to any Argos LUTs or follow-on SDC terminals in the field. The data is also stored onboard for transmission to centrals. Data formats are (*TBS*).

3.2.3.1.8 External Interface to Launch Vehicle

The LSS should coordinate with the Launch Vehicle (LV) contractor for scheduling, status, and launch support at the launch base.

TRD3.2.3.1.8-1
During the pre-separation phase the System shall provide positive inhibits for execution of any stored program commands which have safety implications..

TRD3.2.3.1.8-2
The NPOESS satellite shall be compatible with the physical, mechanical, electrical, and environmental interfaces with the LV, its payload attach fitting, and its payload fairing in accordance with the LV contractor's payload planners guide.

3.2.3.1.9 External Interface to WTR/Launch Site

The LSS should coordinate with the appropriate US Government personnel to arrange for the use of the launch facilities and their equipment for satellite processing.

TRD3.2.3.1.9-1
The LSS shall interface with the Western Test Range and launch control facilities for launch operations.

TRD3.2.3.1.9-2
The extent of the interface with the WTR shall be to verify compliance with the applicable Range Safety Requirements of EWR 127-1, including ground monitoring functions.

3.2.3.1.10 External Interface to NORAD

TRD3.2.3.1.10-1
After the launch of NPOESS satellites, the System shall support requests to NORAD (*TBR*) and receipt from NORAD (*TBR*) of ELSETs for orbit determination whenever any satellite's own orbit determination capability is not operational.

3.2.3.1.11 External Interface to SOC’s Host Facility

The NPOESS primary and backup SOCs will interface with their host facilities and with the ESA's SOC.

3.2.3.1.11.1 External Interface to Primary SOC’s Host Facility

TRD3.2.3.1.11.1-1
The NPOESS primary SOC shall interface with its host facility, the Satellite Operations Control Center (SOCC), for floorspace, power, lighting, air-conditioning, security, and access to communications networks.

3.2.3.1.11.2 External Interface to Backup SOC

TRD3.2.3.1.11.2-1
The NPOESS backup SOC shall interface with its host facility, the Environmental Space Operations Center (ESOC), for floorspace, power, lighting, air-conditioning, security, and access to communications networks.

3.2.3.1.11.3 External Interface to ESA SOC

TRD3.2.3.1.11.3-1
The NPOESS primary SOC at SOCC shall interface with the ESA SOC for coordination and scheduling of METOP ground stations for communications with NPOESS satellites.

TRD3.2.3.1.11.3-2
The NPOESS primary SOC at SOCC shall interface with the ESA SOC to coordinate operationsof the METOP satellites and the transmission of METOP data to the centrals.

TRD3.2.3.1.11.3-3
When in primary control of the NPOESS constellation, the NPOESS backup SOC at ESOC shall interface with the ESA SOC for scheduling of METOP ground stations for communications with NPOESS satellites.

TRD3.2.3.1.11.3-4
When in primary control of the NPOESS constellation, the NPOESS backup SOC at ESOC shall interface with the ESA SOC to coordinate operations of the METOP satellite and the transmission of the data to the centrals.

TRD3.2.3.1.11.3-5
The primary NPOESS SOC at SOCC and the backup SOC at ESOC shall interface with the ESA-SOC to coordinate operationsof the NPOESS satellites and the transmission of data to the centrals.

3.2.3.1.12 External Interface to Shared Resources

The System will interface on a shared basis with AFSCN RTSs, NOAA CDAs, and METOP ground stations, among others and/or the System may interface with TDRSS..

3.2.3.1.12.1 External Interface to AFSCN RTS

The AFSCN RTSs which are considered part of the NPOESS ground station network are a shared resource.

TRD3.2.3.1.12.1-1
The SS shall have the capability to downlink stored mission data and telemetry to the selected AFSCN RTSs .

TRD3.2.3.1.12.1-2
The SS shall have the capability to receive commands and memory uploads which have been transmitted through the selected AFSCN RTSs.

TRD3.2.3.1.12.1-3
The SS shall have the capability to downlink real-time telemetry to selected AFSCN RTSs.

TRD3.2.3.1.12.1-4
The C3 Ground Equipment shall have the capability to receive downlinked stored mission data and telemetry from the selected AFSCN RTSs.

TRD3.2.3.1.12.1-5
The C3S shall have the capability to relay the downlinked stored mission data through the selected AFSCN RTSs.

3.2.3.1.12.2 External Interface to NOAA CDA

The NOAA Command and Data Acquisition (CDA) sites are considered part of the NPOESS ground station network as a shared resource.

TRD3.2.3.1.12.2-1
The SS shall have the capability to downlink stored mission data and telemetry to selected CDAs.

TRD3.2.3.1.12.2-2
The SS shall have the capability to receive commands and memory uploads which have been transmitted through the selected CDAs.

TRD3.2.3.1.12.2-3
The SS shall have the capability to downlink real-time telemetry to the selected CDAs.

TRD3.2.3.1.12.2-4
The C3 Ground Equipment shall have the capability to receive downlinked mission data and telemetry from the selected CDAs.

TRD3.2.3.1.12.2-5
The C3S shall have the capability to relay the downlinked stored mission data through the selected CDAs .

3.2.3.1.12.3 External Interface to METOP Ground Station

Only those METOP ground stations which are considered part of the NPOESS ground station network are a shared resource.

TRD3.2.3.1.12.3-1
The SS shall have the capability to downlink stored mission data and telemetry to the METOP ground stations.

TRD3.2.3.1.12.3-2
The SS shall have the capability to receive commands and memory uploads transmitted through the METOP ground station network.

TRD3.2.3.1.12.3-3
The SS shall have the capability to downlink real-time telemetry to the NPOESS C3 equipment at the METOP ground stations.

TRD3.2.3.1.12.3-4
The C3S shall have the capability to relay the downlinked stored mission data through the METOP ground stations.

3.2.3.1.13 External Interface to Data Routing and Retrieval

All links will comply with National Telecommunications and Information Administration (NTIA) guidelines for spectrum utilization/sharing.

TRD3.2.3.1.13-1
The DRR element of the C3 segment shall be structured to receive sufficient simultaneous links from the ground stations to meet timeliness requirements.

3.2.3.1.14 FVS External Interface to Host Facility

TRD3.2.3.1.14-1
Each FVS shall interface with its host facility for floorspace, power, lighting, air conditioning, security, and access to communications network.

3.2.3.2 Inter-Segment Interface Requirements

The following subparagraphs describe the requirements for the interfaces between the NPOESS segments.

3.2.3.2.1 Space Segment to DoD Field Terminal (Interface Data Processor Segment)

The System will provide two real-time mission data downlinks per satellite between the satellites and the Field Terminal Element of the IDPS: a high data rate downlink and a low data rate downlink.

TRD3.2.3.2.1-1
The communication links between the SS and the DoD Field Terminal element shall provide the capability to prevent intentional interference to the data. Specific requirements are defined in the classified attachment to this TRD.

TRD3.2.3.2.1-2
The communication links between the SS and the DoD Field Terminal element shall provide the capability to prevent unintentional interference to the data. Specific requirements are *(TBR).*

TRD3.2.3.2.1-3

The data format for the communication links between the SS and the DoD Field Terminal element shall be the Consultative Committee for Space Data Systems (CCSDS) format for Advanced Orbiting Systems, Networks and Data Links: Architectural Specification", CCSDS Recommendation 701.0-B-1.

TRD3.2.3.2.1-4
The bit error rate shall be less than or equal to *(TBS)*. For transmission of encrypted data, the bit error rateapplies to transmission from the output of the encryptor to the input of the decryptor (*TBR*).

3.2.3.2.1.1 High Data Rate Downlink Interface

TRD3.2.3.2.1.1-1
The operational frequency band for the high data rate downlink shall be *(TBR)*.

TRD3.2.3.2.1.1-2
The bandwidth for the high data rate downlink shall be *(TBR)* MHz.

TRD3.2.3.2.1.1-3
The data rate shall be *(TBR)*.

TRD3.2.3.2.1.1-4
The modulation and coding for the high data rate downlink shall be offset QPSK with Reed Solomon encoding. Use of convolutional coding as the inner code is optional.

TRD3.2.3.2.1.1-5
The Effective Isotropic Radiated Power (EIRP) for the high data rate downlink shall be *(TBR)* dBm.

TRD3.2.3.2.1.1-6
The polarization for the high data rate downlink shall be *(TBR)*.

TRD3.2.3.2.1.1-7
The high data rate downlink shall continuously transmit (excluding downtime to switchover to backup systems in the event of transmitter failure) the mission data for reception by high data rate terminals.

3.2.3.2.1.2 Low Data Rate Downlink Interface

TRD3.2.3.2.1.2-1
The operational frequency for the low data rate downlink shall be *(TBR)* MHz.

TRD3.2.3.2.1.2-2
The bandwidth for the low data rate downlink shall be *(TBR)* MHz.

TRD3.2.3.2.1.2-3
The data rate shall be *(TBR)*.

TRD3.2.3.2.1.2-4
The modulation and coding for the low data rate downlink shall be offset QPSK with Reed Solomon encoding. Use of convolutional coding as the inner code is optional.

TRD3.2.3.2.1.2-5
The EIRP for the low data rate downlink shall be *(TBR)* dBm.

TRD3.2.3.2.1.2-6
The polarization for the low data rate downlink shall be *(TBR)*.

TRD3.2.3.2.1.2-7
The low data rate downlink shall continuously transmit (excluding downtime to switchover to backup systems in the event of transmitter failure) the mission data for reception by

low data rate terminals.

3.2.3.2.2 Space Segment to/from C3 Segment

The Space Segment will provide three types of RF data links to the C3 Segment: a stored mission data downlink, a command uplink, and a real-time telemetry downlink.

TRD3.2.3.2.2-1
All links between the C3 Segment and the Space Segment shall provide the capability to preclude unauthorized contact.

TRD3.2.3.2.2-2
The bit error rate shall be less than or equal to *(TBS)*. For transmission of encrypted data, the bit error rate applies to transmission from the output of the encryptor to the input of the decryptor (*TBR*).

TRD3.2.3.2.2-3
When encryption is required, all command and telemetry data shall be encrypted/decrypted using National Security Agency (NSA) approved devices.

TRD3.2.3.2.2-4
The data format for the communication links between the Space Segment and the C3 Segment shall be the Consultative Committee for Space Data Systems (CCSDS) format for Advanced Orbiting Systems, Networks and Data Links: Architectural Specification", CCSDS Recommendation 701.0-B-1*(TBR)*.

TRD3.2.3.2.2-5

The C3 segment shall have the capability of receiving NPOESS sensor data from METOP satellites. TT&C support to METOP spacecraft is (TBS) in accordance with international agreement.

3.2.3.2.2.1 Stored Mission Data Downlink Interface

TRD3.2.3.2.2.1-1
The operational frequency band for the stored mission data downlink shall be *(TBR)*.

TRD3.2.3.2.2.1-2
The bandwidth for the stored mission data downlink shall be *(TBR)*.

TRD3.2.3.2.2.1-3
The data rate for the stored mission data downlink shall be *(TBR)* Mbps.

TRD3.2.3.2.2.1-4
The modulation and coding for the stored mission data downlink shall be *(TBR)*.

TRD3.2.3.2.2.1-5
The EIRP for the stored mission data downlink shall be *(TBR)* dBm.

TRD3.2.3.2.2.1-6
The polarization for the stored mission data downlink shall be *(TBR)*.

3.2.3.2.2.2 Command Uplink Interface

TRD3.2.3.2.2.2-1
The operational frequency band for the command uplink shall be *(TBR)*.

TRD3.2.3.2.2.2-2
The bandwidth for the command uplink shall be *(TBR)*.

TRD3.2.3.2.2.2-3
The data rate for the command uplink shall be *(TBR)* kbps.

TRD3.2.3.2.2.2-4
The modulation and coding for the command uplink shall be *(TBR)*.

TRD3.2.3.2.2.2-5
The EIRP for the command uplink shall be *(TBR)* dBm.

TRD3.2.3.2.2.2-6
The polarization for the command uplink shall be *(TBR).*

TRD3.2.3.2.2.2-7
The Space Segment shall be commandable in any orientation of the spacecraft to include tumbling conditions.

3.2.3.2.2.3 Real-time Telemetry Downlink Interface

TRD3.2.3.2.2.3-1
The operational frequency band for the real-time telemetry downlink shall be *(TBR)*.

TRD3.2.3.2.2.3-2
The bandwidth for the real-time telemetry downlink shall be *(TBR)* MHz.

TRD3.2.3.2.2.3-3
The data rate for the real-time telemetry downlink shall be *(TBR)* kbps.

TRD3.2.3.2.2.3-4
The modulation and coding for the real-time telemetry downlink shall be *(TBR)*.

TRD3.2.3.2.2.3-5
The EIRP for the real-time telemetry downlink shall be *(TBR)* dBm.

TRD3.2.3.2.2.3-6
The polarization for the real-time telemetry downlink shall be *(TBR).*

TRD3.2.3.2.2.3-7
The Space Segment shall be able to transmit real-time telemetry in any spacecraft orientation including a tumbling state.

3.2.3.2.3 C3 Segment to Central Element of the Interface Data Processor Segment

TRD3.2.3.2.3-1
The C3 Segment shall interface with the Central Element of the IDPS via high speed data lines with the capacity to handle simultaneous spacecraft transmissions to meet EDR timeliness and early orbit requirements.

3.2.3.2.4 C3 Segment to Launch Support Segment

TRD3.2.3.2.4-1
The LSS shall provide the C3S with the capability to perform required C3 operations during pre-launch operations.

3.2.3.2.5 Space Segment to Launch Support Segment

TRD3.2.3.2.5-1
The LSS shall provide the capability to interface with the satellite to support battery conditioning during pre-launch.

TRD3.2.3.2.5-2

The LSS shall provide the capability to command and monitor the health and status of the satellite via the launch umbilical during launch operations until the moment of launch.

TRD3.2.3.2.5-3
The LSS shall support access to the satellite for launch processing, servicing, and maintenance.

TRD3.2.3.2.5-4
The LSS shall ensure that a launch base processing environment is provided which is within the design limits of the satellite.

3.2.3.3 Infrastructure Support and Interoperability

The NPOESS should be designed to be interoperable and compatible with existing systems. Interoperability means computer systems provided by NPOESS should be able to function with host system architectures existing at the time.

3.2.3.3.1 Transportation and Basing

TRD3.2.3.3.1-1
The modified field terminals shall meet their transportation and basing requirements.

3.2.3.3.2 Standardization, Interoperability, and Commonality

The NPOESS C3 Segment should maximize compatibility with exisiting systems. The NPOESS C3 segment software should be written in a computer language which is compatible with the future equipment selected for the DOC and DoD sites *(TBS).* The software should be interoperable between agencies systems. The NPOESS should comply with appropriate information technology standards (DoD/DOC) applicable at the time of IOC to the extent possible.

TRD3.2.3.3.2-1
The Interface Data Processor Segment for field terminals shall support open systems architectures per ULOSA standards.

3.2.4 Physical Characteristics

3.2.4.1 Mass Properties

TRD3.2.4.1-1
The mass properties of each NPOESS satellite and its associated flight equipment shall meet the requirements of the Launch Vehicle (LV) with no less than a 2% (*TBR*) margin at the final weighing before shipment to the launch facility.

TRD3.2.4.1-2
The mass properties of each satellite shall conform to performance, stability, and control requirements of the LV and the Space Segment.

3.2.4.2 Dimensions

TRD3.2.4.2-1
All measurement units within the System shall be in the International System of Units (SI), unless off-the -shelf hardware precludes this, in which case a waiver demonstrating cost savings is required.

TRD3.2.4.2-2
The dimensional envelope constraints of the size and shape of the NPOESS satellite shall be based upon a combination of static, dynamic, and thermal conditions encountered during factory assembly, system test, transportation and handling, launch, deployment, and on-orbit operations.

TRD3.2.4.2-3
The satellite or sensor configuration shall prevent any unwanted solar reflections from interfering with environmental data collection.

TRD3.2.4.2-4
The dimensional envelope constraints of the size and shape of the ground-based NPOESS elements shall be based upon a combination of building and transportation constraints during the mission.

3.2.4.3 Power

3.2.4.3.1 Satellite Internal Power

High power spacecraft components and sensors should be designed to operate from a 28 volt dc power subsystem.

TRD3.2.4.3.1-1
Primary power distribution to low power components shall be compatible with system and subsystem EMC performance requirements.

TRD3.2.4.3.1-2
Secondary power distribution to low power components shall be compatible with system and subsystem EMC performance requirements.

3.2.4.3.2 Satellite External Power

Unless otherwise specified, satellites undergoing checkout shall be operated from a 28 volt dc, two-wire, single-point negative grounded external power subsystem.

3.2.4.3.3 Wiring

All harnesses should be compatible with the testing and operational environments.

3.2.4.4 Survivability

The NPOESS System Survivability requirements are contained in Appendix B.

3.2.4.4.1 Space Segment NBC Survivability

TRD3.2.4.4.1-1
While on the ground, the satellite shall be protected from NBC contamination by the facilities providing it with contamination and environmental control.

3.2.4.4.2 C3 Segment NBC Survivability

TRD3.2.4.4.2-1
The C3S shall survive during and after exposure to the NBC environments consitent with current facility capabilites as specified in the AFSCN ORD.

3.2.4.4.3 Interface Data Processor Segment NBC Survivability

The Interface Data Processor Segment will be integrated into mobile and fixed systems some of which *(TBS)* are required to meet NBC survivability requirements.

TRD3.2.4.4.3-1

The Interface Data Processor Segment DoD Field Terminals (*TBS*) shall be operable by the user under NBC conditions with the user wearing NBC clothing.

3.2.4.4.4 Electronic Counter Countermeasures (ECCM)

NPOESS ECCM requirements are covered in Appendix B of this document.

3.2.4.5 Interoperability

The NPOESS will be designed to be interoperable and compatible with existing systems. Interoperability means computer systems provided by NPOESS should be able to function with host system architectures existing at the time.

TRD3.2.4.5-1
The NPOESS implementation shall not impact the operational capabilities of existing user systems (DoD/DOC Central and DoD field elements).

3.2.4.6 Endurance

TRD3.2.4.6-1
The operational service life of the contractor-furnished ground-based NPOESS elements shall be no less than 10 years past IOC with a continuous operational duty cycle of 24 hours per day and 365 days per year with prescribed maintenance.

TRD3.2.4.6-2
The on-orbit design life of the satellite, as may be limited by factors such as mechanical wearout, battery life, solar array life, or the exhaustion of expendables, shall be no less than 7 years.

TRD3.2.4.6-3
The design of the satellite shall be such that satellite storage, under controlled conditions, may be planned for as long as 8 years, including up to 3 years for intermittent testing.

TRD3.2.4.6-4
The design service life of the satellite shall be at least 154 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency.

3.2.4.7 Protective Coatings

TRD3.2.4.7-1
The finishes used shall ensure that the completed devices are resistant to corrosion caused by environmental conditions and galvanic action.

TRD3.2.4.7-2
The SS of the NPOESS shall have special coatings for protection of surfaces against deterioration in space environments.

TRD3.2.4.7-3
The SS of the NPOESS shall have special coatings for electrostatic discharge suppression in all environments.

TRD3.2.4.7-4
The SS of the NPOESS shall not use cadmium or zinc platings.

TRD 3.2.4.7-5
Pure tin or tin alloy (>98% Sn) plating shall not be used on electrical devices and hardware for launch and space vehicles. The guiding document for this prohibition is MIL-STD-1547B, "Electronic Parts, Materials, and Processes for Space and Launch Vehicles."

TRD3.2.4.7-6
Both metallic and insulating surfaces in electronic boxes, such as printed wiring assemblies, where contamination could cause electrical malfunction shall be conformally coated unless otherwise insulated or hermetically sealed. This applies to electrical components in launch and space vehicles and their associated ground equipment. MIL-I-46058, or equivalent can be used in selection of conformal coatings and their thicknesses. Unjacketed, flexible shielded cable and ground straps are specifically excluded from this conformal coating requirement.

TRD3.2.4.7-7
Certain components will suffer significant performance degradation if conformally coated. In these situations, non-use of conformal coatings on electrical components and hardware shall be supported by a thorough analysis and be specifically approved by the government on a case by case basis.

3.2.5 System Quality Factors

3.2.5.1 System Operational Availability.

System Operational Availability (A_O) is defined as the probability that a system is operable and ready to perform its mission at any given time. A_O is a function of mean time between critical failure (MTBCF) and mean time to restore functions (MTTRF) and is calculated as:

$$\mathrm{Ao} = \frac{\mathrm{MTBCF}}{\mathrm{MTBCF} + \mathrm{MTTRF}}$$

where:

$$\mathrm{MTBCF} = \frac{\text{operating time}}{\text{number of critical failures}}$$

and:

$$\mathrm{MTTRF} = \frac{\text{total time down from critical failures}}{\text{number of critical failures}}$$

TRD3.2.5.1-1
The A_O of the NPOESS System shall be not less than *(TBS)*.

3.2.5.2 Space Segment.

TRD3.2.5.2-1
The space segment shall be operational 24 hours per day with no on-orbit repair capability.

TRD3.2.5.2-2
The NPOESS space segment shall meet an Ao of not less than 95.00% (*TBR*). Inclusion of the METOP satellites in the requirement is *(TBR)*.

TRD3.2.5.2-3
MTBCF for the space segment shall be no less than *(TBD)* hours.

TRD3.2.5.2-4
MTTRF for the space segment shall not exceed *(TBD)* hours.

3.2.5.2.1 Space Segment Operational Service Life

TRD3.2.5.2.1-1

The NPOESS space segment shall support an operational service life of at least 10 years after IOC.3.2.5.2.2 Maintainability.
The spacecraft design should include maintainability features to ensure timely replacement or test of spacecraft subsystems or sensors prior to launch.

TRD3.2.5.2.2-1
Only remove and replace maintenance actions shall be performed on the satellite after acceptance for shipment or storage by the procuring agency.

TRD3.2.5.2.2-2
Except for software updates, space-based elements of the System shall not require maintenance or repair on-orbit.

TRD3.2.5.2.2-3
Single-point failures of the spacecraft and key sensors shall be eliminated where practical on new or existing designs if they cause critical or catastrophic failures.

TRD3.2.5.2.2-4
Single-point failures of the spacecraft and key sensors shall be eliminated where practical.

TRD3.2.5.2.2-5
Redundancy shall be provided to eliminate credible single-point failures in the spacecraft and key sensors and to ensure that the System availability requirements are satisfied.

TRD3.2.5.2.2-6
For all cases where failure of a redundant element on-orbit would cause loss of mission, a catastrophic or a critical hazard, a capability for automatic switchover to the backup component and/or circuit shall be provided.

TRD3.2.5.2.2-7
The satellite shall remain in a readiness condition following integration and system performance verification so that it is be available for launch within 60 days (45 days objective). At any time from completing integration and performance verification to the end of the satellite storage period the satellite will support a launch event within 60 days of notification (45 days objective).

3.2.5.3 C3 Segment

The requirements below apply to NPOESS equipment only.

TRD3.2.5.3-1
The A_O of the C3 Segment shall be not less than *(TBS)*.

3.2.5.3.1 Fault Detection.

TRD3.2.5.3.1-1
Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault detection shall automatically or manually detect not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment.

3.2.5.3.2 Fault Isolation.

TRD3.2.5.3.2-1
Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault isolation shall automatically or manually identify not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment. The fault isolation should also be operator-initiation capable.

3.2.5.4 IDPS

TRD3.2.5.4-1

The A_O of the IDPS shall be not less than *(TBS)*.

The requirements below apply to NPOESS equipment only.

3.2.5.4.1 Fault Detection.

TRD3.2.5.4.1-1
Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault detection shall automatically or manually detect not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment.

3.2.5.4.2 Fault Isolation.

TRD3.2.5.4.2-1
Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault isolation shall automatically or manually identify not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment. The fault isolation should also be operator-initiation capable.

3.2.5.5 Additional Quality Factors

3.2.5.5.1 System Compatibility

NPOESS capabilities should consider other national and international agencies together with universities/academia and industry, in addition to DOC and DOD users, requirements and should be configured to be compatible, as appropriate, to meet user needs with minimum impact to existing receiver terminals and procedures.

3.2.5.5.2 Transition

TRD3.2.5.5.2-1
During the transition period, NPOESS shall not interfere with the normal operation of the DMSP and POES Systems, except where shared resource allocation by the Satellite Control Authority results in such interference.

3.2.6 Environmental Conditions

Segment requirements to allow for the adverse impacts of the natural environment are to be derived from design life requirements.

3.2.7 Transportability

TRD3.2.7-1
The satellite(s) and the support equipment that must be transported with the satellite shall be designed for ground and air transportation in accordance with best commercial or military practices.

3.2.8 Flexibility and Expansion

TRD3.2.8-1
System flexibility and expansion shall be provided by the System design and architecture.

3.2.8.1 Operational Computer Resource Reserves

A distinction is made between the computer resource reserves required for space elements and for ground elements of the space system. Modification, addition, or replacement of computer resources in space elements after launch is not planned.

TRD3.2.8.1-1
Addition and modification of computer resources in space elements of later flights shall be accommodated by the sensor and spacecraft designs.

TRD3.2.8.1-2
For ground elements of the space system, the design and installation of the equipment shall be such that equipment modifications may be readily made after the initial installation to meet the growth requirements.

3.2.8.1.1 Computer Resource Reserves for Operational Space Elements

For the purposes of this specification, the data processing subsystems of the operational space elements are defined to comprise all computer hardware and software, in the satellite(s), including all interfacing space equipment, all NPOESS developed sensors), and single application, embedded firmware-based processors. This excludes non-NPOESS developed sensors such as S&R and SDC.

TRD3.2.8.1.1-1
Note, however, that the worst case loading, capacity, throughput, and access rate requirements referred to in this specification shall consider and include the requirements placed upon the data processing subsystems of the space elements by *all* sensors, launch vehicle, spacecraft, and system interfaces.

TRD3.2.8.1.1-2
The data processing subsystems of the space elements shall have 100 percent growth margin while meeting the original functional and performance computional requirements, including timing. This requirement allows the growth margin to be used if the government adds additional requirements.

3.2.8.1.1.1 Data Processing Subsystems Processor Reserves

TRD3.2.8.1.1.1-1
Within the processing environment of the data processing subsystems of the space elements, each processor shall have an instruction execution rate sufficient to process a workload that is 100 percent greater than the worst case processor utilization workload that could load that processor.

3.2.8.1.1.2 Data Processing Subsystems Primary Memory Reserves

TRD3.2.8.1.1.2-1
Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have 100 percent greater memory capacity than the worst case memory size requirement for that primary memory component.

TRD3.2.8.1.1.2-2
Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have, or be capable of having, memory added (through modification, addition, or replacement) to attain, a 200 percent greater memory capacity than the worst case memory size requirement for that primary memory component.

3.2.8.1.1.3 Data Processing Subsystems Peripheral Data Storage (Secondary Memory) Reserves

TRD3.2.8.1.1.3-1
Within the environment of the data processing subsystems of the space elements, each peripheral data storage (secondary memory) component shall have 100 percent (TBR) greater storage capacity than the worst case storage requirement for that peripheral data storage component.

TRD3.2.8.1.1.3-2
Within the environment of the data processing subsystems of the space elements, each peripheral data storage (secondary memory) component shall have, or be capable of having, storage added (through modification, addition, or replacement) to attain, a 200 percent (TBR) greater storage capacity than the worst case storage requirement for that peripheral data storage component.

3.2.8.1.1.4 Data Processing Subsystems Data Transmission Media

TRD3.2.8.1.1.4-1
Within the environment of the data processing subsystems of the space elements, each data transmission medium (e.g., local or global bus or channel) shall have sufficient capacity to support data throughput that is 50 percent greater than the worst case data throughput that could load that data transmission medium.

TRD3.2.8.1.1.4-2
Within the environment of the data processing subsystems of the space elements, each data transmission medium (e.g., local or global bus or channel) shall have, or be capable of being augmented (through modification, addition, or replacement) to have, sufficient capacity to support data throughput that is 200 percent greater than the worst case data throughput that could load that data transmission medium.

3.2.8.1.1.5 Data Processing Subsystems Software/Firmware

TRD3.2.8.1.1.5-1
Any hardware augmentations necessary to meet the expansion requirements shall, where practical, be designed so that the software and firmware in the data processing subsystems of the space elements are upward compatible with the implementation of those augmentations.

3.2.8.1.2 Computer Resource Reserves for Operational Ground Equipment

For the purposes of this specification, the operational data processing subsystems of the ground elements of the space system are defined to comprise all computer hardware and software required to support operational missions that are not in space elements.

Reserve requirements to support program expansion in terms of additional use of existing functions are necessary in the ground elements of the operational data processing subsystems of the space system.

TRD3.2.8.1.2-1
The data processing subsystems of the ground elements shall be capable of data throughput that is 100 percent greater than that required to satisfy the worst case data processing requirements that could jointly load the operational ground equipment data processing subsystems of the ground elements.

3.2.8.1.2.1 Data Processing Subsystems Processor Reserves

TRD3.2.8.1.2.1-1
Within the processing environment of the data processing subsystems of the ground elements, each processor shall have an instruction execution rate sufficient to process a workload that is 100 percent greater than the worst case processor utilization workload that could load that processor.

3.2.8.1.2.2 Data Processing Subsystems Primary Memory Reserves

TRD3.2.8.1.2.2-1
Within the environment of the data processing subsystems of the ground elements, the primary memory for each processor shall have 100 percent greater memory capacity than the worst case memory size requirement for that primary memory component, if operating under a nonvirtual operating system.

TRD3.2.8.1.2.2-2
If operating under a virtual operating system, the virtual memory capacity for that processor shall provide for 100 percent greater virtual memory capacity than the worst case virtual memory size requirement for that processor.

3.2.8.1.2.3 Data Processing Subsystems Peripheral Data Storage (Secondary Memory) Reserves

TRD3.2.8.1.2.3-1

Within the environment of the data processing subsystems of the ground elements, each peripheral data storage (secondary memory) component shall have 100 percent greater storage capacity than the worst case storage requirement for that peripheral data storage component.

3.2.8.1.2.4 Data Processing Subsystems Data Transmission Media

TRD3.2.8.1.2.4-1
Within the environment of the data processing subsystems of the ground elements, each data transmission medium (e.g., local or global bus or channel) shall have sufficient capacity to support data throughput that is 100 percent greater than the worst case data throughput that could load that data transmission medium.

3.2.8.1.2.5 Data Processing Subsystems Software/Firmware

TRD3.2.8.1.2.5-1
Any hardware augmentations necessary to meet the expansion requirements specified shall, where practical, be designed so that the software and firmware in each data processing subsystem of the ground elements is upward compatible with the implementation of those augmentations.

3.2.8.2 Nonoperational Computer Resource Reserves

3.2.8.2.1 Computer Software Maintenance Resources: Additional Growth Capability

TRD3.2.8.2.1-1
The computer resources used for computer software maintenance shall be capable of accommodating the specified growth requirements of the operational computer resources without necessitating any major modifications.

3.2.8.2.2 Computer Resources in Training Equipment: Additional Growth Capability

TRD3.2.8.2.2-1
The training equipment (such as the FVSs) shall be capable of accommodating the growth requirements of the operational computational equipment without necessitating major modifications.

3.2.8.2.3 Network Structure

TRD3.2.8.2.3-1
The ground system architecture shall utilize commercial standard networking methods to interlink processing systems.

TRD3.2.8.2.3-2
The capability of the network shall allow for a system growth of 200% in terms of nodes and total amount of data transmitted on the network.

3.2.9 Portability

The System should be designed for portability of software to other open system architecture equipment. Individual equipment/subsystems and components should be designed to be portable, as necessary.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials

TRD3.3.1-1
Unless otherwise specified, the parts, materials, and processes shall be selected and controlled in accordance with contractor documented procedures to satisfy the specified requirements (ref MIL-STD-1543B).

3.3.1.1 Toxic Products and Formulations

TRD3.3.1.1-1
The use of combustible materials or materials that can generate toxic outgassing or toxic products of combustion shall be compliant with applicable federal, state, and local laws and regulations..

3.3.1.2 Parts Selection

Care should be exercised in the selection of materials and processes for the space equipment to avoid stress corrosion cracking in highly stressed parts and to preclude failures induced by hydrogen embrittlement.

Parts, materials, and processes should be selected to ensure that any damage or deterioration from storage or the space environment or the outgassing effects in the space environment would not reduce the performance of the space equipment beyond the specified limits.

TRD3.3.1.2-1

Parts for space usage shall be chosen to meet the reliability and operational service life requirements. (reference MIL-STD-1547B and also Preferred Parts List PPL-21, Goddard Space Flight Center).

TRD3.3.1.2-2Parts shall be selected in accordance with the contractor's Parts Management Plan and the contractor shall be able to demonstrate via data or analysis that all parts meet the reliability and operational service life requirements.

TRD3.3.1.2-3
New items for the ground segments not supported by the logistics supply system shall be used only when existing items are incompatible with the NPOESS ground architecture, or they contain obsolete parts that are not available, or are no longer in production.

TRD3.3.1.2-4
New items shall be used only when the performance of existing items will not meet the requirements of this specification.

3.3.1.3 Material Selection

Materials for the space equipment will be selected for low outgassing in accordance with SP-R-0 022A (NASA JSC) and resistance to the effects of incident radiation. All support facilities, including test facilities and launch base facilities, should comply with the grounding requirements of MIL-STD-1542B and NOAA S24.809.

TRD3.3.1.3-1
Materials shall be selected that have demonstrated their suitability for the intended application.

TRD3.3.1.3-2
Materials shall be corrosion resistant or shall be suitably treated to resist corrosion when subjected to the specified environments.

TRD3.3.1.3-3
Where practicable, fungus inert materials shall be used.

TRD3.3.1.3-4
Class I Ozone Depleting Substances (ODS) shall not be used in the design, test, manufacture, integration and assembly, handling, transportation, operations, maintenance, or disposal of the NPOESS System.

TRD3.3.1.3-5
Use of Class II ODS and EPCRA Section 313 chemicals shall be identified and either eliminated or minimized, justified, and controlled.

TRD3.3.1.3-6
A Hazardous Materials Management Program shall be developed in accordance with NAS 411.

3.3.1.4 Finishes

TRD3.3.1.4-1
The finishes used shall ensure that the completed devices are resistant to corrosion.

TRD3.3.1.4-2
Neither cadmium nor zinc nor tin plating for space equipment shall be used.

3.3.2 Electromagnetic Radiation

TRD3.3.2-1
The satellite segment shall be electromagnetically compatible with itself.

TRD3.3.2-2
The ground segment shall be electromagnetically compatible with its known equipment and any existing equipment residing in the same facility.

TRD3.3.2-3
All support facilities, including test facilities and launch base facilities, shall comply with the ground EMC requirements.

TRD3.3.2-4
The EMC requirements shall be in accordance with MIL-STD-461D.and MIL-STD-1541A.

3.3.3 Nameplates and Product Marking

TRD3.3.3-1
Nameplates for hardware shall contain the item or configuration item number, serial number, lot number (or contract number), manufacturer, and nomenclature.

TRD3.3.3-2
Software media shall be marked to display software configuration item number, serial number, contract number, manufacturer, and nomenclature.

3.3.4 Workmanship

TRD3.3.4-1
Critical steps of fabrication which are item-peculiar shall be detailed in drawing notes which include appropriate workmanship criteria.

TRD3.3.4-2
Workmanship relating to all other aspects of fabrication shall be in accordance with the Quality Control Plan approved for each manufacturing facility.

3.3.5 Interchangeability

TRD3.3.5-1
All ground segments shall be configured for modular replacement of components to expedite maintenance and repair.

TRD3.3.5-2
All components, assemblies, subassemblies, and modules that are identical with respect to fit, form, and function shall be interchangeable.

TRD3.3.5-3
Parts not functionally, electrically and dimensionally interchangeable shall have different part numbers.

3.3.6 Safety Requirements

TRD3.3.6-1
System hazards to personnel, hardware, or the environment shall be identified, controlled, or eliminated during design, test, manufacture, integration and assembly, handling, transportation, and operations of the NPOESS System.

TRD3.3.6-2
Design and operational safety requirements shall be developed and implemented to eliminate or control personnel, hardware, or environmental hazards.

TRD3.3.6-3
Satellites developed for this program shall comply with EWR 127-1 in the areas of design safety, flight termination, launch integration, and ground operations.

TRD3.3.6-4
Software controlling hazardous systems or operations (e.g., propulsion systems, electro-explosive devices, electromechanical release devices, etc.) shall be assessed for hazard severity and probability (ref AFM 91-201and MIL-STD 882).

TRD3.3.6-5
A system safety program shall be established (ref MIL-STD-882c.

3.3.7 Human Engineering

All new facilities and equipment designs, and the design of modifications to existing facilities and equipment should be in accordance with the provisions of MIL-STD-1472D.

TRD3.3.7-1
The operator-hardware and operator-software interfaces shall be designed to maximize safety, efficiency, and usability, and minimize number of personnel, resources, skills, and training.

TRD3.3.7-2
The operator-software interface shall be developed using open systems technology

TRD3.3.7-3
The operator-software interface shall be designed using an iterative design methodology consisting of rapid prototyping, usability evaluation, and feedback to design.

3.3.8 Nuclear Control

TRD3.3.8-1
Provisions shall be made for the control of all nuclear materials, such as radioactive sources, used in manufacturing, calibration, and checkout of certain mission sensors.

3.3.9 System Security

3.3.9.1 COMSEC, TEMPEST, and COMPUSEC

3.3.9.1.1 Communications Security (COMSEC)

Communications security (COMSEC) measures provide protection for the transmission of sensitive information.

TRD3.3.9.1.1-1
When encryption is required, satellite commands and telemetry shall be encrypted at the source and decrypted at the final destination.

TRD3.3.9.1.1-2
When encryption is required, mission data downlinked by the satellite shall be encrypted at the source and decrypted at the final destination.

TRD3.3.9.1.1-3
SDC and S&R data downlinked in realtime shall always be unencrypted. SDC data contained in the stored data downlink may be encrypted.

TRD3.3.9.1.1-4
All commands to the satellite shall be source authenticated.

TRD3.3.9.1.1-5
The satellite shall not accept invalid commands, noise, or spoofing as valid commands.

TRD3.3.9.1.1-6
Commands that fail authentication shall not be executed.

TRD3.3.9.1.1-7
Commands that fail authentication shall be reported in telemetry.

TRD3.3.9.1.1-8
A single failure shall not result in the disclosure of classified NPOESS information.

3.3.9.1.2 Compromising Emanations (TEMPEST)

NPOESS TEMPEST requirements should be based on site specific guidance while being consistant with the HIJACK and NONSTOP requirements of NACSEM 5112, and the requirements of NSTISSI 7000.

3.3.9.1.3 Computer Security (COMPUSEC)

Any NPOESS element that processes multiple security levels of data should comply with DOD 5200.28-STD, paragraph 3.1.1.3.

TRD3.3.9.1.3-1
NPOESS data shall reside in and operate under an environment that meets the class C2 criteria as defined by DOD 5200.28-STD paragraph 2.2.

TRD3.3.9.1.3-2
NPOESS shall provide the capability to verify the integrity and source of all information transferred between elements.

TRD3.3.9.1.3-3
NPOESS shall provide the capability to restrict subjects' (e.g., operators') privileges to access only those objects (e.g., data and programs) necessary to perform their tasks.

3.3.10 Government Furnished Property Usage

The NPOESS IPO will arrange for units of the following Field Terminal types to be made available for modification and test: Mark IVB, Mark IV, STT, AN/SMQ-11 & TESS-3, IMETS, and TMQ-44 and/or planned follow-on terminals.

The SDC and S&R sensors for the NPOESS satellites will be provided to the NPOESS as GFE (with the exception of the antennas). Other sensors for the NPOESS satellites which will be GFE or directed subcontracts are TBS.

The government will furnish the appropriate encryption equipment.

Any military aircraft required to transport NPOESS satellites to the launch base will be provided as Government Furnished Services.

For each NPOESS satellite launch, the launch vehicle, its payload fairing, the use of the launch base facilities, and the support of the launch vehicle contractor may be provided by the US Government.

3.3.10.1 Standard Scenes

The government will provide standard images and sounder data sets for EDR performance validation. Up to 5 images in each of the 44 (TBR) categories/areas listed below will be provided to the contractor for use in developing sensor designs, and in verifying sensor and algorithm performance. The government will create an additional set of up to 5 images in each area/category which will be used by the government to determine sensor design performance and algorithm performance. Note that the specific geographic areas identified are respresentative of climate regimes, and may change depending on the availability of terrain background data.

Terrain areas and categories for standard scenes (TBR). There are 24 areas in all. For each area except polar, there will be day and night categories as well, making the total 44 areas / categories of standard datasets. The areas will all be 360km X 360 km (3.25☜ X 3.25☜) anchored at the NW corner identified above.

Climate Area	Spring	Summer	Autumn	Winter	Location (NW Corner)
Polar					
Land: Siberia		X		X	70N 103E
Coast: Point Barrow		X		X	72N 159W
Tropics					
Land: Amazon Basin		X		X	5S 65W
Coast: Cameroon		X		X	5N 8E
Ocean: E. Pacific		X			8N 120W
Midlatitudes					
Land: W. Urals	X	X	X	X	56N 56E
Coast: Olympic Peninsula	X	X	X	X	48N 126W
Desert: Great Basin	X	X	X	X	41N 118W
Ocean: Azores				X	45N 30W
Alpine: Swiss Alps			X		48N 8E
Sub-Tropical: Bangladesh				X	25N 88E

3.3.11 Computer Resources

Computer resources include all computer software and the associated computational equipment included within the System.

3.3.11.1 Operational Computer Resources

3.3.11.1.1 Operational Computational Equipment

The computational equipment includes processing units; special-purpose computational devices; main storage; peripheral data storage; input and output units such as printers, graphic displays, video display devices; and other associated devices.

3.3.11.1.2 Operating Systems Used in Operational Computers

TRD3.3.11.1.2-1
The operational computers shall be able to exchange information with their host facility systems.

3.3.11.1.3 Operational Application Software

3.3.11.1.3.1 Programming Language

Where practicable, IDPS operational application computer software should be written in compliance with ANSI/ISO/TEC 8652:1955 Ada '95.

TRD3.3.11.1.3.1-1
System software shall be written in a higher order language except where assembly language is necessary for the satisfaction of System performance requirements or where its use is cost-effective over the life of the system.

3.3.11.1.3.2 Message Generation

TRD3.3.11.1.3.2-1
The ground operational computer software shall generate error messages, diagnostic messages, and alarm messages on-line to facilitate real-time fault isolation required to maintain the System in operational status.

TRD3.3.11.1.3.2-2
In addition, these ground operational computer software shall generate off-line error and diagnostic messages for the logging of fault messages onto system files for those categories of faults which require isolation and correction but can be addressed off-line and do not degrade System performance.

3.3.11.1.3.3 Computer Resource Utilization Monitoring

TRD3.3.11.1.3.3-1
All ground operational computer resources shall provide a capability which can be exercised under operator control to monitor, record, display, and print the utilization of the various computer resources.

TRD3.3.11.1.3.3-2
All space operational computer resources shall provide a capability which can be exercised under operator control to monitor and record the utilization of the various computer resources.

3.3.11.1.4 Software Coding Conventions

TRD3.3.11.1.4-1
Code shall be written such that no code is modified during execution.

3.3.11.2 Computer Resources in Test Equipment

Test equipment is that equipment required to support the maintenance, repair, and checkout of the System hardware following System deployment.

3.3.11.3 Computer Resources in Training Equipment

TRD3.3.11.3-1
To the extent practicable, the computational training equipment that provides operator displays and controls shall be identical to the corresponding operational computational equipment.

3.3.12 Satellite Design Requirements

3.3.12.1 General Structural Design

TRD3.3.12.1-1
The primary support structure for the space equipment shall possess sufficient strength, rigidity, and other characteristics required to survive the critical loading conditions that exist within the envelope of handling and mission requirements.

3.3.12.2 Strength Requirements

3.3.12.2.1 Yield Load

TRD3.3.12.2.1-1
The structure shall be designed to have sufficient strength to withstand simultaneously the yield loads, applied temperature, and other accompanying environmental phenomena for each design condition without experiencing yielding or detrimental deformation.

3.3.12.2.2 Ultimate Load

TRD3.3.12.2.2-1
The structure shall be designed to withstand simultaneously the ultimate loads, applied temperature, and other accompanying environmental phenomena without failure.

3.3.12.3 Stiffness Requirements

3.3.12.3.1 Dynamic Properties

TRD3.3.12.3.1-1
The structural dynamic properties of the equipment shall be such that its interaction with the satellite control subsystem does not result in unacceptable degradation of performance.

3.3.12.3.2 Structural Stiffness

TRD3.3.12.3.2-1
Stiffness of the structure and its attachments shall be controlled by the equipment performance requirements and by consideration of the handling and launch environments.

TRD3.3.12.3.2-2
Special stowage provisions shall be used, if required, to prevent excessive dynamic amplification during transient flight events.

3.3.12.3.3 Component Stiffness

TRD3.3.12.3.3-1
The fundamental resonant frequency of a component weighing 23 kilograms or less shall normally be 50 Hertz (*TBR*) or greater when mounted on its immediate support structure.

TRD3.3.12.3.3-2

Detailed analyses of the potential responses of the component to inputs from the adjoining structure(s) shall be required for components weighing 23 kilograms or less and having fundamental resonant frequencies of less than 50 Hertz (*TBR*).

3.3.12.4 Structural Factors of Safety

The factor of safety of the structure is the ratio of the limit load to the allowable load.

3.3.12.4.1 Flight Limit Loads

TRD3.3.12.4.1-1
Available options for structural design are listed in Table I. All safety-related structural design requirements shall be met.

TABLE I. STRUCTURAL DESIGN FACTORS OF SAFETY

Design and Test Options	Design Factor of Safety of Limit Loads	
	Yield	Ultimate
	(FSy)	(FSu) Unmanned Events
1. Dedicated Test Article	1.100	1.25
2. Test One Flight Article	1.25	1.40
3. Proof Test Each Flight Article	1.10	1.25
4. No Static Test	1.60	2.00

3.3.12.4.2 Pressure Loads

TRD3.3.12.4.2-1
Factors of safety for pressure loads shall be determined individually for each pressure vessel, based on tests to establish material characteristics and an analysis of life requirements and other environmental exposure.

TRD3.3.12.4.2-2
Proof and burst pressure factors shall be established at levels that ensure structural integrity, structural life, and safety throughout all phases. The values listed in Table II are to be considered as limiting lower bounds.

TABLE II. FACTORS OF SAFETY FOR PRESSURIZED COMPONENTS

	Design	Acceptance	Qualification
Component	Ultimate	Proof	Burst
Solid Rocket Motor Cases[a]	1.25	1.10[b]	1.25[b]
Pneumatic Vessels[a]	2.00	1.50[b]	2.00[b]
Pneumatic Vessels[a]	4.00	2.00	4.00[b]
Lines, Fittings, and Hoses			
Less than 3.81 cm diameter[c]	4.00	2.00[b]	4.00[b]

3.81 cm diameter and larger[c]	1.50	1.10[b]	1.50[b]
Other Pressurized Components	2.50	2.00[b]	2.50[b]

Notes:

a. Factors of safety shown are minimum values applicableto metallic pressure vessels for which ductile fracture mode is predicted via a combination of stress and fracture mechanics analyses. Design of metallic pressure vessels for which brittle fracture mode is predicted by these analyses should be in accordance with fracture mechanics methodology wherein the proof factor as well as the design ultimate factor of safety should be established to provide a minimum of four times the specified service life against mission requirements. In addition, a fracture control program should be established to prevent structural failure dueto the initiation or propagation of flaws or crack-like defects during fabrication, testing, and servicelife.

b. No measurable *(TBR)* yielding is permitted at acceptance (proof) test pressure and no rupture at qualification pressure.

c. 3.81cm diameter is equivalent to 1.5in diameter.

3.3.12.5 Design Load Conditions

TRD3.3.12.5-1
The satellite equipment shall be capable of withstanding all design load conditions to which it is exposed in all mission phases, as applicable: ground, prelaunch, erection, post-launch, boost and orbit.

TRD3.3.12.5-2
During the orbit phase, all of the following shall be considered: maneuvering loads, vehicle spin, meteoroid environment, radiation environment, and other environmental factors, such as thermal effects due to internal heating, solar heating, eclipses, and extreme cold due to ambient space environment.

3.3.12.6 Satellite Fluid Subsystems

3.3.12.6.1 Pressurized Components

Fluid subsystem and pressurized components should be in accordance with MIL-STD-1522A.

TRD3.3.12.6.1-1 EWR127-1shall be used for design and test of all pressurized systems.

3.3.12.6.2 Tubing

TRD3.3.12.6.2-1
Tubing design shall incorporate provisions for cleaning and to allow proof testing.

3.3.12.6.3 Separable Fittings

TRD3.3.12.6.3-1
Separable fittings shall have redundant sealing surfaces, such as double *"O"* rings, and be of the *"parallel loaded"* type. *"Parallel loaded"* means that the fitting contains a compressed element which exerts outward pressure on the other elements of the fitting such that both seals are maintained even if relaxation occurs.

TRD3.3.12.6.3-2

Separable fittings shall have provisions for locking.

TRD3.3.12.6.3-3
Separable fittings shall be accessible for leak tests and for torque checks.

TRD3.3.12.6.3-4
Separable fittings shall not be designed or assembled with lubricants or fluids that could cause contamination or could mask leakage of a poor assembly.

TRD3.3.12.6.3-5
Separable fluid fittings shall not use "B" nuts unless all of the following constraints are met:
(1) The fittings are comprised of one or more compressed or internally pressure-energized members which maintain a seal even if stress relaxation occurs in any of the other components.
(2) The fittings have redundant seals in series.
(3) The fittings are lockwired to prevent any rotation between the fitting and the nut.

3.3.12.7 Moving Mechanical Assemblies

TRD3.3.12.7-1
Deployment mechanisms, sensor mechanisms, pointing mechanisms, drive mechanisms, de-spin mechanisms, separation mechanisms, and other moving mechanical assemblies on satellites shall be in accordance with MIL-A-83577B.

3.3.12.8 Explosive Ordnance

TRD3.3.12.8-1
All safety-related explosive ordnance design requirements shall be met.

TRD3.3.12.8-1
Explosive ordnance to be installed on a satellite shall be in accordance with DOD-E-83578A

3.3.12.9 Wiring

See 3.2.4.3.3.

3.3.12.10 Electronic Components

See paragraph 3.3.1.2 Parts Selection

3.3.12.11 Solar Arrays

(TBD)

3.3.12.12 Embedded Nonoperational Elements

TRD3.3.12.12-1
Any non-operational elements of the space system that are embedded in space elements, such as self-test circuitry, computer software, or other features not required during on-orbit operations, shall be designed to the applicable requirements of the operational elements in which they are embedded.

3.3.13 Operational Ground Equipment: General Design Requirements

3.3.13.1 General Structural Design

TRD3.3.13.1-1
The primary support structure for the ground equipment shall possess sufficient strength, rigidity, and other characteristics required to survive the critical loading conditions that exist within the envelope of handling and mission requirements.

TRD3.3.13.1-2
The primary support structure of the equipment shall be electrically conductive.

TRD3.3.13.1-3
The primary support structure of the equipment shall permit the implementation of a single-point electrical ground.

3.3.13.2 Strength Requirements

3.3.13.2.1 Yield Load

TRD3.3.13.2.1-1
The structure shall be designed to have sufficient strength to withstand simultaneously the yield loads, applied temperature, and other accompanying environmental phenomena for each design condition without experiencing yielding or detrimental deformation.

3.3.13.2.2 Ultimate Load

TRD3.3.13.2.2-1
The structure shall be designed to withstand simultaneously the ultimate loads, applied temperature, and other accompanying environmental phenomena without failure.

3.3.13.3 Stiffness Requirements

3.3.13.3.1 Dynamic Properties

TRD3.3.13.3.1-1
The structural dynamic properties of the equipment shall be such that its interaction with the environment does not result in unacceptable degradation of performance.

3.3.13.3.2 Structural Stiffness

TRD3.3.13.3.2-1
Stiffness of the structure and its attachments shall be controlled by the equipment performance requirements and by consideration of the handling, transport, and operational environments.

TRD3.3.13.3.2-2
Special stowage and tie-down provisions shall be used, if required, to prevent excessive dynamic amplification during transient events such as installation and transport.

3.3.13.4 Structural Factors of Safety

The factor of safety of the structure is the ratio of the limit load to the allowable load.

3.3.13.4.1 Transport Limit Loads

TRD3.3.13.4.1-1
Available options for structural design are listed in Table III. All safety-related structural design requirements shall be met.

TABLE III. GROUND EQUIPMENT STRUCTURAL DESIGN FACTORS OF SAFETY

Design and Test Options	Design Factor of Safety on Limit Loads	
	Yield	Ultimate

1. Static Proof Test Each Air Transportable Article	1.10	1.40
2. No Static Test (analysis only)	1.60	2.25

3.3.13.4.2 Pressure Loads

TRD3.3.13.4.2-1
Factors of safety for pressure loads shall be determined individually for each pressure vessel, based on tests to establish material characteristics and an analysis of life requirements and other environmental exposure.

TRD3.3.13.4.2-2
Proof and burst pressure factors shall be established at levels that ensure structural integrity, structural life, and safety throughout all phases.

TRD3.3.13.4.2-3
The values listed in Table IV shall be considered as limiting lower bounds.

TRD3.3.13.4.2-4
Federal, State, and local safety regulations shall be met.

3.3.13.5 Design Load Conditions

TRD3.3.13.5-1
The equipment shall be capable of withstanding all design load conditions to which it is exposed.

3.3.13.5.1 Air Transportation Load Factors

TRD3.3.13.5.1-1
The load factors applied to the C-130, C-141, C-5 and C-17 air transport environments shall be 1.5.

3.3.13.5.2 Ground Transportation Load Factors

TRD3.3.13.5.2-1
The ground transportation load factors shall be 1.5.

3.3.13.6 Fluid Subsystems

3.3.13.6.1 Pressurized Components

Fluid subsystems and pressurized components should be in accordance with MIL-STD-1522A. For all equipment, all safety-related pressurized component design requirements shall be met.

TABLE IV. FACTORS OF SAFETY FOR GROUND EQUIPMENT PRESSURIZED COMPONENTS

	Design	Acceptance	Qualification
Component	Ultimate	(Proof)	
Pneumatic Vessels[a]	2.00	1.50[b]	2.00[b]
Lines, Fittings, and Hoses			
Less than 3.81 cm diameter	4.00	2.00[b]	4.00[b]
3.81 cm diameter and larger	1.50	1.10[b]	1.50[b]
Other Pressurized Components	2.50	2.00[b]	2.50[b]

Notes:

a. Factors of safety shown are minimum values applicable to metallic pressure vessels for which ductile fracture mode is predicted via a combination of stress and fracture mechanics analyses. Design of metallic pressure vessels for which brittle fracture mode is predicted by these analyses should be in accordance with fracture mechanics methodology wherein the proof factor as well as the design ultimate factor of safety should be established to provide a minimum of four times the specified service life against mission requirements. In addition, a fracture control program should be established to prevent structural failure due to the initiation or propagation of flaws or crack-like defects during fabrication, testing, and service life.

b. No yielding is permitted at acceptance (proof) test pressure and no rupture at qualification pressure.

3.3.13.6.2 Tubing

TRD3.3.13.6.2-1
Tubing shall be stainless steel, where practicable.

TRD3.3.13.6.2-2
Tubing joints shall be thermal welded butt joints, where practicable.

TRD3.3.13.6.2-3
Tubing design shall incorporate provisions for cleaning and to allow proof testing.

3.3.13.6.3 Separable Fittings

TRD3.3.13.6.3-1
Separable fittings shall have provisions for locking. Separable fittings should be accessible for leak tests and for torque checks. Separable fittings should not be designed or assembled with lubricants or fluids that could cause contamination or could mask leakage of a poor assembly.

3.3.14 Nonoperational Ground Equipment: General Design Requirements

Non-operational ground equipment is ground equipment that is used off line in such areas as training, maintenance, or transportation and is not required during on-orbit operations.

3.3.14.1 Embedded Nonoperational Elements

TRD3.3.14.1-1
Any non-operational ground equipment that is embedded in operational ground equipment, such as self-test circuitry, computer software, or other features not required during on-orbit operations, shall be designed to the applicable requirements of the operational ground equipment in which they are embedded.

3.3.14.2 Other Nonoperational Ground Equipment

3.3.14.2.1 Test Equipment

Test equipment is that equipment required to support the maintenance, repair, and checkout of the System following System deployment.

TRD3.3.14.2.1-1
To the extent practicable, test equipment shall be designed using applicable commercial practices.

TRD3.3.14.2.1-2
Commercially available modules shall be used to the extent practicable.

3.3.15 General Construction Requirements

3.3.15.1 Processes and Controls for Space Equipment

Acceptance and flight certification of space equipment is based primarily on an evaluation of data from the manufacturing process.

TRD3.3.15.1-1
The manufacturing process for space equipment shall be accomplished in accordance with documented procedures and process controls which assure the reliability and quality required for the mission.

TRD3.3.15.1-2
These manufacturing procedures and process controls shall be documented to give visibility to the procedures and specifications by which all processes, operations, inspections, and tests are to be accomplished by the supplier.

TRD3.3.15.1-3
This internal contractor documentation shall include the name of each part or component, each material required, the point it enters the manufacturing flow, and the controlling specification or drawing.

TRD 3.3.15.1-4
The documentation shall indicate required tooling, facilities, and test equipment; the manufacturing check points; the quality assurance verification points; and the verification procedures corresponding to each applicable process or material listed.

TRD3.3.15.1-5
The specifications, procedures, drawings, and supporting documentation shall reflect the specific revisions in effect at the time the items were produced.

TRD3.3.15.1-6
These flow charts and the referenced specifications, procedures, drawings, and supporting documentation become the manufacturing process control baseline and shall be retained by the supplier for reference.

TRD3.3.15.1-7
It is recognized that many factors may warrant making changes to this documented baseline; however, all changes to the baseline processes used, or the baseline documents used, shall be recorded by the supplier following

establishment of the manufacturing baseline. These changes provide the basis for flight accreditation of the items manufactured or of subsequent flight items.

TRD3.3.15.1-8
The manufacturing process and control documents for space equipment shall provide a supplier-controlled baseline that assures that any subsequent failure or discrepancy analysis that may be required can identify the specific manufacturing materials and processes that were used for each item. In that way, changes can be incorporated to a known baseline to correct the problems.

3.3.15.1.1 Assembly Lots

TRD3.3.15.1.1-1
To the extent practicable, parts for use in space equipment shall be grouped together in individual assembly lots during the various stages of their manufacture to assure that all devices assembled during the same time period use the same materials, tools, methods, and controls.

TRD3.3.15.1.1-2
Parts and devices for space equipment that cannot be tested adequately after assembly without destruction of the item, such as explosive ordnance devices, some propulsion components, and complex electronics, shall have lot controls implemented during their manufacture to assure a uniform quality and reliability level of the entire lot.

TRD3.3.15.1.1-3
Each lot shall be manufactured, tested, and stored With sequential lot numbers that indicate the date of manufacture should be assigned to each lot. (Typically, use three digits for the day of the year and two digits for the year.)

3.3.15.1.2 Contamination

3.3.15.1.2.1 Fabrication and Handling

TRD3.3.15.1.2.1-1
Fabrication and handling of space equipment shall be accomplished in a clean environment.

TRD3.3.15.1.2.1-2
Attention shall be given to avoiding nonparticulate (chemical) as well as particulate air contamination.

TRD3.3.15.1.2.1-3
To avoid safety and contamination problems, the use of liquids shall be minimized in areas where initiators, explosive bolts, or any loaded explosive devices are exposed.

3.3.15.1.2.2 Device Cleanliness

The particulate cleanliness of internal moving subassemblies should be maintained to at least level 500 as defined in MIL-STD-1246C.

TRD3.3.15.1.2.2-1
External surfaces shall be visibly clean.

3.3.15.1.2.3 Outgassing

TRD3.3.15.1.2.3-1
Items that might otherwise produce deleterious outgassing while on orbit shall be baked for a sufficient time to drive out all but an acceptable level of outgassing products prior to installation in the experiment or satellite.

TRD3.3.15.1.2.3-2
Analytical contamination models shall be used to evaluate performance impacts of outgassing on adjacent critical equipment.

3.3.15.1.3 Electrostatic Discharge

TRD3.3.15.1.3-1
Appropriate provisions shall be used to avoid and to protect against the effects of static electricity generation and discharge in areas containing electrostatic sensitive devices such as microcircuits, initiators, explosive bolts, or any loaded explosive device. MIL-HDBK-263B provides examples of appropriate provisions.

TRD3.3.15.1.3-2
There shall be a capability to ground both equipment and personnel working on and around the satellite, subsystems, and components.

3.3.15.1.4 Mechanical Interfaces

TRD3.3.15.1.4-1
Where practicable, a common interface drill template shall be used to assure correct mechanical mating, particularly for interfaces external to the equipment.

3.3.15.2 Processes and Controls for Ground Equipment

TRD3.3.15.2-1
The manufacturing processes and controls for ground equipment shall be selected and documented using the same criteria as used in the manufacture of similar commercial equipment.

3.4 DOCUMENTATION

3.4.1 Specifications

TRD3.4.1-1
Functional and physical requirements for the NPOESS System shall be documented in a hierarchical set of specifications, comprising system, segment, and element levels. MIL-STD-490A provides guidance on hierarchical specifications. Lower level specifications are able to be used to define requirements for software or individual units.

3.4.1.1 Facility Drawings

TRD3.4.1.1-1
Installation drawings shall be prepared for each facility, showing the locations of fixed equipment and the utilities required to serve it. For easily relocatable equipment such as computer workstations or desktop printers, locations are shown for their network connections.

3.4.2 Interface Control Documents

TRD3.4.2-1
Interface Control Documents (ICDs) shall be used to define and control the interfaces within the NPOESS System and between the NPOESS System and external users. :

TRD3.4.2-2
ICDs shall be provided for spacecraft bus to all mission sensors.

TRD3.4.2-3
An ICD shall be provided for METOP bus to mission sensors (*TBS).*

TRD3.4.2-4
An ICD shall be provided for Space Segment to C3 Segment.

TRD3.4.2-5

An ICD shall be provided for Space Segment to non-NPOESS mission sensors (such as S&R sensor).

TRD3.4.2-6
An ICD shall be provided for C3 Segment to IDP Segment.

TRD3.4.2-7
An ICD shall be provided for Launch Support Segment to Spacecraft.

TRD3.4.2-8
An ICD shall be provided for Launch Support Segment to C3 Segment.

TRD3.4.2-9
An ICD shall be provided for Intra-Segment Element to Element.

TRD3.4.2-10
An ICD shall be provided for IDP Segment to Centrals.

3.4.3 Drawings and Associated List

TRD3.4.3-1
Equipment designed for NPOESS shall be documented in drawings and associated lists.

3.4.4 Software (Including Databases).

NPOESS software and databases should be developed and managed in accordance with MIL-STD-498 and NOAA software standards. MIL-STD-498 will take precedence.

3.4.5 Technical Manuals

All technical manuals will be commercial off-the-shelf, if adequate descriptive documentation is contained within the manuals to perform the tasks intended. If this is not the case, then all technical manuals should meet the requirements of NOAA Standards S24.801 and S24.806, TM 86-01, and other applicable specifications.

TRD3.4.5-1
The Technical Manuals Plan shall govern the development and/or delivery of all required hardware and software maintenance and operations manuals.

3.5 LOGISTICS

Integrated Logistics Support (ILS) should minimize the impact of NPOESS on the existing support infrastructure while ensuring the lowest NPOESS life cycle cost and while providing full and timely logistics response. This goal should be accomplished by the application of sound supportability decisions regarding mission equipment design, support systems development, and support products acquisition.

TRD3.5-1
Supportability criteria shall be imposed on equipment selection and System designs to minimize the System life cycle costs.

3.5.1 Maintenance Planning

All maintenance procedures will be approved by the USG.

3.5.1.1 Space Segment Maintenance Concepts

The ground support equipment should be addressed in the segment.

3.5.1.2 C3 Segment Maintenance Concepts

The NPOESS C3 Ground Equipment will be operated by a mix of USG civilian and military personnel and contractors. The USG requires maintenance of the NPOESS C3 Ground Equipment including equipment installed at the SOCs and any NPOESS unique equipment installed at the CDAs/RTSs. This maintenance is required during development, installation, Initial Operational Test and Evaluation (IOT&E), Initial Operations, and for 12 months after final operational capability (FOC) is certified (hereinafter referred to as the extended maintenance period).

TRD3.5.1.2-1.
Remedial and preventive maintenance of the C3 Ground Equipment is an NPOESS contractor function and shall be consistent with stated requirements for overall NPOESS System availability and reliability.

TRD3.5.1.2-2.
The NPOESS System delivered shall include options for additional one year periods of C3 Ground Equipment hardware and software maintenance upgrades throughout the program life cycle.

TRD3.5.1.2-3
The C3 Ground Equipment shall have sufficient diagnostic and failure detection capabilities (hardware and software) to allow USG operations staff to be alerted immediately to system failures.

TRD3.5.1.2-4 The C3 Ground Equipment which experiences a failure shall be returned to operations within 4 hours.

TRD3.5.1.2-5
The C3 Ground Equipment shall be configured to allow hardware and software components to be repaired or replaced without the loss of data or spacecraft mission to a level meeting specified NPOESS System availability requirements. Hardware may either be repaired or replaced, but approved procedures will predetermine these actions.

TRD3.5.1.2-6
Sufficient redundancy shall exist that hardware and software upgrades can be installed and tested on non-critical portions of the system without affecting the ongoing operations.

TRD3.5.1.2-7
A maintenance capability shall be provided at both SOCs on 24 hours per day, 7 days per week basis.

TRD3.5.1.2-8
A response time of 30 minutes or less shall be provided for this support.

3.5.1.3 IDP Segment Maintenance Concept

TRD3.5.1.3-1
The maintenance concept for the IPD segment shall support the negotiated 12 month warranty which starts from the date of the successful launch of the second NPOESS satellite and covers all non-GFE equipment, parts, labor, and software (including COTS).

TRD3.5.1.3-2
The IDPS equipment with the failed components shall be returned to operations within 4 hours.

TRD3.5.1.3-3
The ability to complete fault isolation shall be within 30 minutes.

3.5.1.3.1 Centrals

IDPS hardware and software require operational maintenance at all central sites. The maintenance tasks associated with the IDPS at DoD and NOAA will be different. Any requirements defined in this section relating to the production and delivery of EDRs refer exclusively to the DoD IDPS locations.

TRD3.5.1.3.1-1
For both NOAA and DoD, remedial and preventive maintenance of interface hardware delivered to acquire NPOESS data streams at Centrals is expected to be an NPOESS contractor function and shall be consistent with stated requirements for overall NPOESS System availability and reliability and product delivery timeliness.

TRD3.5.1.3.1-2
Maintenance of the entire IDPS, including processing equipment and software needed to generate EDRs at DoD Centrals, during development, installation, Initial Operational Test and Evaluation (IOT&E), Initial Operations, and for 12 months after final operational capability (FOC) is certified (hereinafter referred to as the extended maintenance period) shall be provided.

TRD3.5.1.3.1-3
The IDPS at Centrals shall have sufficient diagnostic and failure detection capabilities (hardware and software) to allow USG operations staff to be alerted immediately to system failures.

TRD3.5.1.3.1-4
The IDPS at Centrals shall be configured to allow hardware and software components to be repaired or replaced without the loss of data to a level meeting specified NPOESS System availability requirements. Hardware may either be repaired or replaced, but approved procedures will predetermine these actions.

TRD3.5.1.3.1-5
Sufficient redundancy shall exist that hardware and software upgrades can be installed and tested on non-critical portions of the system without affecting the ongoing operations.

3.5.1.3.2 DoD Field Terminals.

Field level maintenance of the hardware and software at the DoD field terminals is required and will be performed by DoD personnel following appropriate IDPS hardware and software maintenance training, and consistent with the field terminal operations and maintenance concepts.

Depot level hardware and software maintenance of the IDPS elements of the DoD field terminals will be an NPOESS contractor function.

3.5.2 Provisioning Strategy/Spares Concept.

Spare parts should be provided for the NPOESS C3 Ground Equipment and IDP segment subsystems to ensure overall NPOESS System reliability and availability.

3.5.3 Support Equipment

The need for unique support equipment should be minimized by the careful selection of COTS hardware and software.

3.5.4 Packaging, Handling, Storage, and Transportation (PHS&T).

TRD3.5.4-1
The contractor shall provide a PHS&T plan which will cover all PHS&T issues for the NPOESS program.

3.5.5 Facilities.

Existing government facilities may be available for operations, maintenance, or storage of NPOESS systems.

3.6 PERSONNEL AND TRAINING

TRD3.6-1
A Training System Requirement Analysis and Training Plan shall be developed outlining training requirements to prepare personnel for NPOESS operations and software/hardware maintenance. These should be developed using the Training System Requirements Analysis Book as a guide.

3.6.1 C3 Segment.

The goal for NPOESS C3 Segment training is for USG operations and maintenance personnel to be certified as qualified to operate the hardware and software of the NPOESS C3 Ground Equipment. Qualification will be certified by the contractor training instructors following execution of a training plan subject to USG approval.

TRD3.6.1-1
The training plan to meet this goal shall cover all aspects of hardware and software needed to insure operational continuity of the NPOESS C3 Segment.

3.6.2 IDP Segment.

The goal of IDPS training is for USG operations and maintenance personnel to be certified as qualified to operate and maintain the hardware and software of the IDPS. Qualification will be certified by the contractor training instructors following execution of a training plan subject to USG approval.

TRD3.6.2.-1
A training plan to meet this goal covering all aspects of hardware and software needed to insure operational continuity of the NPOESS data acquisition, data quality control, and EDR processing and distribution shall be provided.

TRD3.6.2.-2
All USG operations staff shall be fully trained before IOC.

3.7 SEGMENT CHARACTERISTICS

This section states the requirements that have been allocated to the segments. However, to avoid duplication requirements that normally would appear in both 3.2 and 3.7 are only stated in this section.

3.7.1 Space Segment (SS)

The space segment consists of a constellation of satellites and ground support equipment.

3.7.1.1 Constellation Requirements

NPOESS satellites should be equally spaced to the maximum extent possible and should provide adequate coverage of the dawn/dusk transitions and the approximate noon/midnight fluctuations of the ionosphere and magnetosphere.

TRD3.7.1.1-1
NPOESS satellites shall be flown at a nodal crossing time of approximately 0530 LST (ascending), approximately 1330 LST (ascending), and 2130 (ascending) to optimize satisfaction of DoD and DOC requirements. The 0930 orbit may be satisfied by METOP flying NPOESS furnished sensors. If the 0930 orbit is satisfied by the METOP satellite, then only two US NPOESS satellites will be needed; they will be flown in the 0530 and 1330 orbits.

TRD3.7.1.1-2
All satellites in the NPOESS constellation shall be sun-synchronous such that each satellite images/measures the same latitude at approximately the same local solar time (LST) each day.

TRD3.7.1.1-3

The NPOESS satellites shall be capable of flying at any equatorial nodel crossing time. As a goal, the equatorial node crossing times should be selectable by the users and the constellation should still achieve mission requirements.

3.7.1.2 Satellite Requirements

TRD3.7.1.2-1
The satellite shall be capable of being launched into the specified orbit from VAFB on a LV.

TRD3.7.1.2-2
A NPOESS satellite shall commence safe operations when an anomalous condition occurs from which the satellite is not able to automatically recover and which threatens the health and status of the satellite in a time frame that is not sufficient for the anomaly to be resolved.

TRD3.7.1.2-3
During safe operations, the satellite shall sustain the capability to receive a command uplink from the C3 Segment and to transmit a real-time health and status telemetry downlink to the C3 Segment.

TRD3.7.1.2-4
Once safe operations are no longer required, the satellite shall cease safe operations and commence normal operations upon ground command from the C3 Segment.

TRD3.7.1.2-5
The NPOESS satellites shall be configured to reduce the generation of space debris to the maximum extent possible in accordance with National Space Policy Directive 1 and USSPACECOM Reg 57-2. As a goal, NPOESS satellites should be configured so when they are either non-mission capable or nearing their end of life, they can be removed from operational orbits.

TRD3.7.1.2-6
The NPOESS satellites shall be compatible with the environments for their operational orbits as specified in accepted standards such as: e.g.- MIL-STD-1809 (USAF) Space Environments for USAF Space Vehicles; NASA SP-8031: Meteoroids; NASA Tech Memorandum 100471: Man-made Orbital Debris; and the Handbook of Geophysics and Space Environments.

3.7.1.3 Ground Support Equipment

TRD3.7.1.3.1-1
Ground Support Equipment shall be provided by the contractor to satisfactorily perform tests that will demonstrate that the satellite meets all of the requirements. This includes subsystem testing, systems test, and unique equipment for launch support.
3.7.1.4 Sensor Suites
All passive microwave sensor sounding bands should be in either the dedicated, or the shared, ITU tables for passive sensor use IAW the "Manual of Regulations and Procedures for Federal Radio Frequency Management") September 1995 Edition.

TRD3.7.1.4-1 Requirement to have each channel commandable is *(TBR)*.

3.7.1.4.1 Visible/Infrared Imager Radiometer Suite (ViiRS) *(TBS)*

3.7.1.4.2 Cross-Track Infrared Microwave Profiler Suite (CrIMS) *(TBS)*

3.7.1.4.3 Conical Microwave Imager Suite (CMIS) *(TBS)*

3.7.1.4.4 Space Environmental Suite (SES) *(TBS)*

The Space Environmental Suite consists of either a multi-spectral sensor or sets of sensors that provide data on electron density profiles, neutral density, solar extreme ultraviolet radiation, geomagnetic field, precipitating electrons and ions, electric field/ion drift velocity, radiation dose, neutral atmosphere, galactic cosmic rays, trapped particles, ionospheric scintillation, auroral emissions and airglow image, in-situ plasma measurements and other selected environmental parameters. *(TBS)*

3.7.1.4.5 GPS Occultation Suite (GPSOS) *(TBS)*

3.7.1.4.6 Ozone Mapping Profiling Suite (OMPS) *(TBS)*

3.7.1.4.7 Surface Data Collection

TRD3.7.1.4.7-1
The NPOESS Space Segment shall have the capability to provide SDC on at least 2 (*TBS*) satellites.

3.7.1.4.8 Search and Rescue

TRD3.7.1.4.8-1
The NPOESS Space Segment shall have the capability to provide S&R functions on at least 2 (*TBS*) satellites.

3.7.2 Command, Control, and Communications Segment

The NPOESS C3S should be designed to take maximum advantage of the experience that the NOAA and DOD operators have with respect to the operation of the current POES and DMSP satellite control systems. NPOESS should have standardized communications protocols to the maximum extent possible to ensure interoperability between the military Services, DoD and civil communities, and allied systems.

TRD3.7.2-1
The NPOESS C3S shall provide all functions required for day-to-day state of health monitoring and commanding of all operating spacecraft and to support the delivery of data to the Centrals. As a goal, the C3S and the IDPS components at centrals should adhere to a common system architecture with common system software and, if applicable, common hardware.

TRD3.7.2-2
The C3S will survive during and after exposure to the natural environments specified in the AFSCN ORD as tailored for the local climate.

3.7.2.1 Satellite Operations Center

The SSOC and ESOC should be compatible with existing military standards and civil protocols to ensure seamless transition during backup operations, continuity of data flow and processing, and ease of maintenance.

TRD3.7.2.1-1
The primary SOC shall be capable of performing the operational functions of satellite command and control, mission planning, antenna resource scheduling, launch and early orbit, anomaly resolution, data access, and the delivery of data to Centrals for the entire NPOESS constellation.

TRD3.7.2.1-2
The backup SOC shall be capable of performing the same operational functions as the primary SOC, with the exception that launch and early orbit operations will only be done from the primary SOC.

TRD3.7.2.1-3
The hardware and software located at the primary and backup SOCs shall be functionally identical and operated and maintained using the same commands and procedures.

3.7.2.2 Environmental Support

Environmental data, analyses, alerts, advisories, and forecasts are required to support mission operations, satellite mission planning, launch support, satellite tracking, real-time decision making, anomaly resolution, and other operational activities. These items are invaluable for the protection of resources and assets. In addition, spacecraft operators use these data to account and correct for drag errors, bearing and range errors, and a variety of satellite anomalies, including spacecraft charging, single event upsets, and satellite disorientation. Communications personnel use these data to compensate for signal loss due to ionospheric absorption; for signal amplitude and/or phase variation caused by scintillation and scattering; and radio frequency interference caused by solar radio frequency bursts.

TRD3.7.2.2-1
The NPOESS shall acquire space, near-earth, and terrestrial environmental data in order to perform its mission.

3.7.2.3 Data Routing and Retrieval (DRR) Element

TRD3.7.2.3-1
The DRR element shall provide all inter-element communications for the C3S and the IDPS which includes the routing (from ingest at the ground stations) of both stored mission data and telemetry, and real-time telemetry to the SOCs and stored mission data to the IDPS Central element.

TRD3.7.2.3-2
The DRR element shall provide routing for commands, mission planning requests, and any other communications between the SOC, ground stations, FVS Element, IDPS central element, and external interfaces.

3.7.2.4 Ground stations Element

TRD3.7.2.4-1
The C3S shall use ground stations at NOAA's CDAs at Fairbanks, Alaska and Wallops Island, Virginia and AFSCN RTSs as needed to meet the data availability requirements.

TRD3.7.2.4-2
The ground stations at Kiruna, Sweden or Tromso, Norway may be capable of being used to augment capabilities, but all NPOESS requirements for the operational mode shall be able to be met without that augmentation *(TBS).* Similarly, other C3 architectures may be evaluated, such as TDRSS.

3.7.2.5 Flight Vehicle Simulator Element

The FVS element will be able to use a FVS at the primary SOC, the backup SOC, and the satellite production facility.

TRD3.7.2.5-1
The FVS element shall be capable of simulating any of the on-orbit satellites. Interface equipment may be required to integrate spacecraft hardware to the FVS element.

TRD3.7.2.5-2
A control workstation shall be provided as part of each FVS to monitor and control the health and welfare of simulated satellites.

TRD3.7.2.5-3
The control workstation for the FVS element shall be capable of executing scenarios for training, emergency procedures, and flight and ground software test and certification.

TRD3.7.2.5-4
The FVS element shall be modular and provide for growth in functions and data throughput.

3.7.2.6 C3S Inter-Element Interface Requirements

TRD3.7.2.6-1
The SOC shall interface with the RTS/CDAs in the NPOESS ground station network to send the contents of the command uplink and receive the stored data and real-time telemetry downlinks.

TRD3.7.2.6-2
The DRR shall interface with the RTS/CDAs in the NPOESS ground station network to receive the mission data streams from the stored mission data downlinks.

TRD3.7.2.6-3
The SOC shall interface with the FVS element to simulate sending commands to an NPOESS satellite and receiving responses back from an NPOESS satellite for operational and training purposes.

3.7.3 Interface Data Processor Segment

The IDPS will be comprised of Central and Field Terminal Elements.

TRD3.7.3-1
The IDPS shall earth locate all NPOESS sensors data in geodetic latitude and longitude corrected for altitude within the accuracy specified for each EDR in Appendix D, accounting for satellite position and attitude, sensor characteristics, earth geoid and other factors as required.

TRD3.7.3-2
The design of the IDPS element shall permit the use of ancillary data sources as required to generate the EDRs specified in Appendix E *(TBS).*

TRD3.7.3-3
Each IDPS element shall have a Data Base Management System (DBMS) to provide the users access to RDRs, SDRs, and EDRs.

TRD3.7.3-4
The IDPS shall calibrate and correct the data, as appropriate to meet the interface specification requirements for data format.

3.7.3.1 IDPS Central Element

TRD3.7.3.1-1
Each IDPS Central element shall be capable of processing *(TBR)* simultaneously downloaded mission data streams to meet RDR, SDR, or EDR timeliness requirements as appropriate.

TRD3.7.3.1-2
The IDPS shall be expandable up to one hundred percent growth in storage and processing capacity.

TRD3.7.3.1-3
The IDPS shall not overwrite the RDR/SDR/EDR fields for 24 hours *(TBR).*

3.7.3.1.1 IDPS for DoD Centrals (AFGWC, 50 WS, FNMOC, NAVOCEANO)

TRD3.7.3.1.1-1
The IDPS DBMS shall have adequate storage to store and have available for retrieval *(TBS)* the RDRs, SDRs *(TBS)*, and EDRs as specified in Appendix E for 24(TBR) hours of data per NPOESS satellite. The DBMS shall have adequate storage for *(TBS)* satellites.

TRD3.7.3.1.1-2
The IDPS shall process EDRs as specified in Appendix E within 20 minutes of receipt of satellite data (see para 3.2.1.2.1).

TRD3.7.3.1.1-3
The IDPS shall process the EDRs to the performance specification in Appendix D

3.7.3.1.2 IDPS for DoC Centrals (NOAA/NESDIS)

The IDPS at NOAA NESDIS is not required to process EDRs. Therefore, for the "DoC only" EDRs identified in Appendix D, operational code to process the EDR is not required; however, algorithm development is required to the extent necessary to validate that the RDR product is adequate to meet EDR performance specification.

TRD3.7.3.1.2-1
The IDPS DBMS shall have adequate storage capacity to allow access to the RDRs as specified in Appendix E for 24 hours of data per NPOESS satellite.

TRD3.7.3.1.2-2
The DBMS shall have adequate storage for *(TBS)* satellites.

3.7.3.2 Interface Data Processor Field Terminal Element

TRD3.7.3.2-1
The time to process EDRs as specified in Appendix E shall not exceed 20 minutes after loss of signal.

TRD3.7.3.2-2
The IDPS shall have imagery data, including SDRs, available for display within 2 minutes after receipt of data.

3.7.3.2.1 IDP for High Data Rate Field Terminals

TRD3.7.3.2.1-1
The IDPS shall process the EDRs to the performance specification in Appendix D.

TRD3.7.3.2.1-2
Performance degradation due to lack of availability of ancillary data shall be documented.

TRD3.7.3.2.1-3
The IDPS shall contain enough online storage to store and have available for retrieval the RDRs, imagery SDRs *(TBS)*, and EDRs as specified in Appendix E for the last 24(TBR) hours. The IDPS may use compression techniques on all but the most recent pass to meet the storage requirement.

3.7.3.2.2 IDP for Low Data Rate Field Terminals

TRD3.7.3.2.2-1
The IDPS shall process the EDRs to the performance specification in Appendix D.

TRD3.7.3.2.2-2
Performance degradation as a result of receiving the lowdata rate link (i.e. only a subset of the mission data), due to the use of lossy data compression, or lack of avilability of ancillary data shall be documented.

TRD3.7.3.2.2-3
The Basic STT IDPS shall contain enough online storage to store four passes (*TBR*) of low data rate imagery.

TRD3.7.3.2.2-4
The Basic STT IDPS shall contain enough online storage to store and have available for retrieval the nonimagery derived RDRs, imagery SDRs *(TBS)* and EDRs as specified in Appendix E for the last 48(TBR) hours. The IDPS may use compression techniques on all but the most recent pass to meet the storage requirement.

3.7.4 Launch Support Segment

TRD3.7.4-1
The LSS shall have the capability to perform the required tests and operations necessary to successfully support the launch of an NPOESS satellite into orbit.

TRD3.7.4-2
The LSS shall provide access to the satellite for launch processing, servicing, and maintenance.

TRD3.7.4-3
The LSS shall develop plans and procedures for pre-launch contingency operations.

TRD3.7.4-4
The LSS shall support post-launch operations at the launch base.

TRD3.7.4-5
The LSS shall support satellite command simulation and testing.

3.7.4.1 Ground Support Equipment (GSE)

TRD3.7.4.1-1
The LSS shall provide the necessary launch base Ground Support Equipment (GSE) and software for the completion of launch operations.

TRD3.7.4.1-2
The LSS shall ensure that factory handling, carting, and LV mating equipment are designed for safe shipping, handling, and transportation of the satellite vehicle and associated equipment.

4. QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION.

Unless otherwise specified in the contract the contractor is responsible for the performance of all inspection and test requirements specified herein. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Philosophy of Testing.

The test requirements for the operational elements are separated into those applicable to space segment (satellite equipment) and those applicable to the C3 and Interface Data Processor segments. The specified tests provide general screening checks, but they are necessarily insufficient to assure absolutely the reliability of the satellite. In-process screening tests, including stress screening, should be used at the parts, materials, and subassembly levels, and at all subtier levels where appropriate, to assure a reliable satellite. The acceptance tests at the satellite level provide a final check for any gross errors.

In addition, the non-space elements of the System required to support on-orbit operations should be adequately tested to assure satisfactory support of the space missions. Finally, the prelaunch system-level tests and inspections are conducted to verify that each critical path in the launch system and in the on-orbit system is satisfactory.

Proper design requires that items at each level of assembly have broader parameter tolerances and narrower environmental ranges than the subtier items that are used in its fabrication. In that way, manufacturing defects can be screened out at the lowest level of assembly possible, and items that pass subtier screening tests should not be expected to fail during subsequent tests at higher levels of assembly. Also, critical parameters that cannot be measured accurately at higher levels of assembly should be evaluated at lower levels of assembly. This usually means that some form of stress-screening tests are cost effective at subtier levels

Note that part screening usually is conducted using the maximum range of design or qualification conditions in the part specifications. Assuming proper applications of the parts, those conditions always would be more severe than the conditions specified for subassembly or component screening. Since the subassembly or component tests do not duplicate the stringent conditions of part-level testing, they should never be viewed as a substitute for part-level screening.

4.1.2 Location of Testing.

Tests and evaluations of the space elements may be conducted at in-plant test facilities, which may include subcontractor's facilities and/or at a government-approved test facility. The part, material, and software unit development tests and evaluations, tests of ground equipment and of computer software also may be conducted at in-plant test facilities, which may include subcontractor's facilities or at a government-approved test bed.

TRD4.1.2-1
Where practicable, integrated system tests of ground equipment and of computer software shall be performed on integrated CIs installed in an operational system. Whenever possible, these tests should be conducted at a specified target site with the support of the operational personnel. A development test bed sufficiently simulating the operational system capability for test purposes may be used for integrated system tests, if target sites, operational complexes, or other suitable operational support areas are not available.

TRD4.1.2-2
Prelaunch system-level inspections and tests shall be conducted on the operational system with the satellite mated with the launch vehicle, using operational interfaces to the extent practicable.

4.2 SPECIAL TESTS AND EXAMINATIONS

4.2.1 Inspections and Tests of Operational Elements of the On-orbit Space System

4.2.1.1 Inspections and Tests of the Space Elements

4.2.1.1.1 Satellite Parts, Materials, and Process Controls.

Parts, materials, and process controls are to be applied during production of all items to ensure that a reliable system is fabricated.

TRD4.2.1.1.1-1
During fabrication of the satellite and other space equipment, the tools and processes, as well as parts and materials, shall be adequately controlled and inspected to assure compliance with the approved manufacturing processes and controls.

4.2.1.1.1.1 Satellite Records.

TRD4.2.1.1.1.1-1
Records documenting the status of the satellite and other space equipment shall be maintained following assignment of serial numbers.

TRD4.2.1.1.1.1-2
Each space item shall have inspection records and test records maintained by serial number to provide traceability from system usage to production lot data for the devices.

TRD4.2.1.1.1.1-3
Complete records shall be maintained for the space items.

TRD4.2.1.1.1.1-4
and shall be available for review during the service life of the System.

TRD4.2.1.1.1.1-5
The records shall indicate all relevant test data, all rework or modifications, and all installations and removals for whatever reason.

TRD4.2.1.1.1.1-6
Ground equipment items shall have inspection records and test records maintained by serial number for the service life of the item.

4.2.1.1.1.2 Satellite Manufacturing Screens.

TRD4.2.1.1.1.2-1
Each critical subassembly, component, experiment, and satellite shall be subjected to in-process manufacturing and assembly screens to assure compliance with the specified requirements to the extent practicable.

TRD4.2.1.1.1.2-2
At each level of assembly, each completed unit shall be subjected to visual inspection to assure that it is free of obvious defects and is within specified physical limits.

4.2.1.1.1.3 Nonconforming Material.

TRD4.2.1.1.1.3-1
Nonconforming material, components, or assemblies that do not meet the established tolerance limits set for the acceptance limits in the in-process screens shall be rejected for use. Any rejected material, component, or assembly may be reworked and rescreened in accordance with established procedures if System reliability is not jeopardized. Non-conforming material or

assembled units in each lot may be reworked and re-screened in accordance with established procedures if the rework is not so extensive as to jeopardize the lot identity of the material or assembled unit. If the reworked material or assembled unit subsequently passes the in-process screens, it again can be considered part of the lot.

TRD4.2.1.1.1.3-2
Reassignment of assembled units to a different lot shall not be made. Nonconforming material or assembled units that do not satisfy these rework criteria will be considered scrap.

4.2.1.1.2 Satellite Design Verification Tests.

TRD4.2.1.1.2-1
Design verification testing shall be performed to demonstrate compliance of new designs or of modified designs with the specified performance margins.

TRD4.2.1.1.2-2
Test units shall be sufficiently similar to the final production units so as not to invalidate the test results.

4.2.1.1.2.1 Engineering Tests

4.2.1.1.2.1.1 Verification of Nonoperating Constraints.

The effects of non-operational environments on the space equipment may be determined by nonoperating development tests. These tests would be used to identify fabrication, storage, handling, transportation, installation, and launch preparation constraints or controls that might be necessary.

4.2.1.1.2.1.2 Development Tests.

TRD4.2.1.1.2.1.2-1
Development tests shall be performed as required to yield information necessary to determine design feasibility.

TRD4.2.1.1.2.1.2-2
Development tests shall be performed as required to yield information necessary to determine adequacy of basic design approaches.

TRD4.2.1.1.2.1.2-3
Development tests shall be performed as required to yield information necessary to determine functional parameters.

TRD4.2.1.1.2.1.2-4
Development tests shall be performed as required to yield information necessary to determine thermal and structural data with particular emphasis on deployment, separation, latching mechanisms, clearances, structural dynamic characteristics, and math model verification.

TRD4.2.1.1.2.1.2-5
Development tests shall be performed as required to yield information necessary to determine mass properties.

TRD4.2.1.1.2.1.2-6
Development tests shall be performed as required to yield information necessary to determine packaging and fabrication techniques.

TRD4.2.1.1.2.1.2-7
Development tests shall be performed as required to yield information necessary to determine stabilization performance.

TRD4.2.1.1.2.1.2-8
Development tests shall be performed as required to yield information necessary to determine EMC.

TRD4.2.1.1.2.1.2-9

Development tests shall be performed as required to yield information necessary to determine safety.

TRD4.2.1.1.2.1.2-10
Development tests shall be performed as required to yield information necessary to determine cleanliness requirements and contamination compatibility.

4.2.1.1.2.1.3 Modal Survey.

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TRD4.2.1.1.2.1.3-1
An appropriate test shall be performed on each subsystem physically separable assembly such as spacecraft appendages (solar arrays, antennas, …) and subassemblies to identify the primary resonant frequencies. If the measured frequencies are greater than the upper frequency of the model required for the launch vehicle, then those frequencies may be the only data needed.

TRD4.2.1.1.2.1.3-2
A modal survey test shall be required for all systems/subsystems whose primary resonant frequencies are not greater than the upper frequency of the model required for the launch vehicle.

TRD4.2.1.1.2.1.3-3
All natural modes of vibration at frequencies below 50 Hz shall be determined.

4.2.1.1.2.1.4 Static Loads.

TRD4.2.1.1.2.1.4-1
A static loads test as specified in MIL-STD-1540C shall be performed on the first satellite or a structural test unit..

4.2.1.1.2.1.5 Thermal Balance.

TRD4.2.1.1.2.1.5-1
The satellite shall be subjected to a thermal balance test as specified in Paragraph 6.2.8 of MIL-STD-1540C.

TRD4.2.1.1.2.1.5-2
The test shall include both maximum and minimum power dissipation modes.

TRD4.2.1.1.2.1.5-3
If heat pipes are included, the attitude of the equipment shall be such as to not bias the test measurements.

TRD4.2.1.1.2.1.5-4
A thermal math model shall be used to correlate pretest temperature predictions with the test data from the thermal balance test. As a goal, correlation of test results to the thermal model predictions should be within ñ 3° C. The correlated thermal math model then is used to make final temperature predictions for all mission phases and, hence, verify the thermal margins required by MIL-STD-1540C.

4.2.1.1.2.1.6 Current Margin.

TRD4.2.1.1.2.1.6-1
Electrical current margins on all electro-explosive ordnance circuits shall be demonstrated.

TRD4.2.1.1.2.1.6-2
The test shall verify that no less than the minimum recommended firing current (twice all-fire) will be delivered to the electro-explosive devices under worst conditions of minimum voltage and maximum circuit and electro-explosive device resistance.

TRD4.2.1.1.2.1.6-3
The test also shall verify that the maximum current delivered to the electro-explosive device does not exceed its maximum qualified firing current under worst conditions of maximum voltage and minimum circuit and electro-explosive device resistance.

4.2.1.1.2.1.7 Mechanism Motion Test.

TRD4.2.1.1.2.1.7-1
The deployment and latching devices shall be tested to demonstrate adequate functioning under worst case environments.

4.2.1.1.2.1.8 Shock.

TRD4.2.1.1.2.1.8-1
Equipment susceptible to shock shall be evaluated for bench handling (nonoperating) and, while operating, for possible pyroshock effects.

4.2.1.1.2.1.9 Outgassing.

Outgassing evaluation tests are required for materials, components, and subsystems whose outgassing properties are not known.

4.2.1.1.2.1.10 High Pressure.

TRD4.2.1.1.2.1-1
Tests of all pressure subsystems of the integrated equipment shall be performed in accordance with MIL-STD-1540C (Paragraph 6.2.6).

4.2.1.1.2.2 Standard Scenes

The government will use standard datasets and sensor performance models to test the performance of contractor sensor designs and algorithms, as well as supply standard datasets to contractors for their use in developing designs which meet the TRD requirements.

TRD4.2.1.1.2.2-1
The contractor shall provide to the IPO sufficient design-specific information and science algorithms to allow the IPO to accurately model the performance of the design, including (TBR) parameters for each sensor

4.2.1.1.3 Protoqual Tests

4.2.1.1.3.1 Component Level.

TRD4.2.1.1.3.1-1
Protoqual tests shall be performed to demonstrate, to the extent it is practicable, that satellite components that are manufactured in accordance with the approved processes and controls meet the specified design requirements.

TRD4.2.1.1.3.1-2
Except as specified herein, the first article manufactured of each type shall be protoqual or qualification tested in accordance with the component level tests in MIL-STD-1540C. The 3 dB, 5° C, or other design factors of safety or margins that are included in the design requirements specified herein include test condition tolerances that are those allowed in MIL-STD-1540C. When the actual test tolerances are less than those specified in MIL-STD-1540C, the qualification test levels may be reduced appropriately in accordance with provisions specified in MIL-STD-1540C.

TRD4.2.1.1.3.1-3
All protoqual tests shall be conducted with hardware of the final design that have passed the in-process production screens.

4.2.1.1.3.1.1 Requalification of Existing Designs.

Requalification is required for items that incorporate extensive changes in design, manufacturing processing, environmental levels, or performance requirements. However, methodology presented in MIL-HDBK-340 may be used to show that existing designs, or items previously qualified for other applications, have adequately demonstrated compliance to all qualification requirements for the new designs. Deficiencies in meeting some requirements may be fulfilled by supplementing existing data with new test data.

TRD4.2.1.1.3.1.1-1
However, qualification by similarity shall be permitted only with the concurrence of the contracting officer. Waiver of qualification or requalification requirements requires the approval of the contracting officer.

4.2.1.1.3.2 Satellite Level Protoqual Tests.

TRD4.2.1.1.3.2-1
Protoqual tests shall be performed to demonstrate, to the extent it is practicable, that satellites that are manufactured in accordance with the approved processes and controls meet the specified design requirements.

TRD4.2.1.1.3.2-2
Except as specified herein, the first vehicle manufactured shall be protoqual tested in accordance with the vehicle level tests in MIL-STD-1540C. The 3-dB, 5° C, or other design factors of safety or margins that are included in the design requirements specified herein include test condition tolerances that are those allowed in MIL-STD-1540C. When the actual test tolerances are less than those specified in MIL-STD-1540, the protoqual test levels may be reduced appropriately in accordance with provisions specified in MIL-STD-1540C.

TRD4.2.1.1.3.2-3
All protoqual tests shall be conducted with hardware of the final design that have passed the in-process production screens.

4.2.1.1.4 Acceptance Tests.

TRD4.2.1.1.4-1
Acceptance tests shall be performed as the basis for acceptance of items manufactured. Acceptance tests, including lot certification testing, is that testing performed to demonstrate confidence that production devices that have passed the in-process production screening also meet the other requirements specified.

4.2.1.1.4.1 Component Level Acceptance Tests.

TRD4.2.1.1.4.1-1
Except as specified herein, space components shall be acceptance tested in accordance with the component level tests in MIL-STD-1540C.

TRD4.2.1.1.4.1-2
For space components that cannot be tested adequately after assembly and must rely upon the process controls and in-process production screening to assure satisfactory performance and reliability, appropriate lot certification tests shall be imposed.

4.2.1.1.4.2 Lot Certification Tests.

Space parts, materials, and components that cannot be tested adequately after assembly, and must rely upon the process controls and in-process screening to assure satisfactory performance and reliability, shall have appropriate lot certification tests imposed prior to assembly.

4.2.1.1.4.3 Satellite Level Acceptance Tests.

TRD4.2.1.1.4.3-1
Except as specified herein, satellite acceptance testing shall be in accordance with the vehicle level tests in MIL-STD-1540C.

4.2.1.1.5 Satellite Service Life Verification Tests.

Service life verification tests are defined as those tests conducted on limited life devices to demonstrate that production devices will perform satisfactorily during their specified service life.

TRD4.2.1.1.5-1

Explosive ordnance devices and other components whose performance may degrade with time shall have life extensions based upon passing either an aging surveillance test or an accelerated aging test.

4.2.1.2 Inspections and Tests of Ground Equipment and Computer Software.

TRD4.2.1.2-1
Functional testing of ground equipment CIs and major components shall be conducted to demonstrate compliance with the specified requirements.

4.2.1.2.1 Part and Material Level Development Tests and Evaluations.

TRD4.2.1.2.1-1
Part and material development tests and evaluations shall be conducted as required to qualify parts, materials, and processes to assure proper application in the design, to assure adequate performance margins, and to develop acceptance criteria for the items to avoid assembling defective hardware components.

4.2.1.2.2 Subassembly Level Development Tests and In-process Tests and Inspections.

TRD4.2.1.2.2-1
Subassemblies shall be subjected to development tests and evaluations as may be required to demonstrate feasibility, to minimize design risk, and to assess the design and manufacturing alternatives and tradeoffs required to best achieve the development objectives.

TRD4.2.1.2.2-2
Tests shall be conducted as required to develop in-process manufacturing tests, inspections, and acceptance criteria for the items to avoid assembling defective hardware items.

4.2.1.2.2.1 Single Configuration Item (CI) Compliance Tests.

4.2.1.2.2.1.1 Hardware CI Qualification.

TRD4.2.1.2.2.1.1-1
Each HWCI type shall be formally qualified to verify compliance with design or specified requirements.

TRD4.2.1.2.2.1.1-2
The qualification tests shall verify that the CI meets the specified system design requirements allocated to the CI, including external interfaces.

TRD4.2.1.2.2.1.1-3
The qualification tests shall verify the performance margins by evaluating the functional performance of the CI in an environment that simulates the operational environments associated with the CI.

4.2.1.2.2.1.2 Hardware CI Acceptance.

The qualification tests on the first production item of each type serve as the acceptance test for that item.

TRD4.2.1.2.2.1.2-1
Subsequent production items of each type shall be formally acceptance tested as required. The acceptance tests of the subsequent production items may be a subset of the qualification tests.

4.2.1.2.2.1.3 Computer Software CI Qualification.

TRD4.2.1.2.2.1.3-1
Formal qualification tests shall be conducted on each CSCI to verify CSCI compliance with design or specified requirements, i.e., stressing the CSCIs to the limits of specified requirements such as MIL-STD-498.

4.2.1.2.2.2 Combined CI Compliance Tests.

TRD4.2.1.2.2.2-1
A series of compliance tests shall be conducted on expanding strings of CIs.

TRD4.2.1.2.2.2-2
The tests shall be designed to confirm functional compatibility among the mechanical, electrical, and computer software interfaces.

TRD4.2.1.2.2.2-3
Tests shall demonstrate that the end item functions resulting at each test sequence of combined CIs meet the performance requirements and system specifications.

4.2.1.2.2.3 Commercial Off-the-shelf or Government-Furnished Equipment Testing.

Commercial off-the-shelf (COTS) items that are not developed specifically for acquisition or modification often are included in the System design. Also, GFE may be included in the System design. The COTS or GFE items may be either hardware, software, or a combination of the two.

TRD4.2.1.2.2.3-1
If incorporated in the System design, the COTS and GFE testing shall be included in the testing baseline, that is, as incorporated in the configuration tested for compliance.

4.2.1.2.3 Integrated System Testing.

TRD4.2.1.2.3-1
Integrated System tests shall be designed to exercise, as near as practical and possible, the total System.

TRD4.2.1.2.3-2
Where practicable, integrated System tests shall be performed on integrated CIs installed in an operational System.

TRD4.2.1.2.3-3
The integrated System tests shall incorporate tests of the affected interfaces of the ground equipment and software with other elements of the operational System.

TRD4.2.1.2.3-4
The integrated tests shall be structured as appropriate to demonstrate design requirements of the System related to such items as performance, electromagnetic compatibility, reliability, maintainability, system safety (hazardous noise, radiation hazards, pressure vessels), logistics supportability, operational procedures, and personnel performance.

TRD4.2.1.2.3-5
Tests shall be focused on the external interfaces involved, the use of operational databases and operational scenarios, and the System requirements from a mission operations perspective.

TRD4.2.1.2.3-6
The tests also shall include System safety tests, inspections, and evaluations in such areas as hardware inspections for electrical and mechanical hazard, including caution labeling; evaluation of the fire suppression system; evaluation of emergency systems; use of any hazardous materials; possibility of personnel exposure to any equipment and ambient noise levels considered hazardous; RF radiation testing to determine actual levels of radiation to which personnel may be exposed and to evaluate the accuracy of the mathematical predictions of radiation levels; proper functioning of any radiation warning systems; and proper procedures for inspection, operation, and maintenance of pressure vessels.

4.2.1.2.4 Initial Operational Test and Evaluation.

Initial operational tests and evaluations (IOT&E) are conducted with the equipment in its operational configuration, in an operational environment, by the operating personnel or an independent test organization. These operational tests are conducted in an environment that is as operationally realistic as possible and practical in order to test and evaluate the effectiveness and suitability of the hardware and software in meeting operational requirements.

4.2.1.2.5 Final Operational Test and Evaluation.

Final operational tests and evaluations (FOT&E) are conducted with the equipment in its operational location by the operating personnel or an independent test organization. These tests demonstrate and verify the continued capability of the System, with the modification or upgrade incorporated, to support ongoing missions. The FOT&E are conducted to refine estimates made during IOT&E and to identify operational System deficiencies.

4.2.2 Prelaunch Validation Tests.

TRD4.2.2-1
To the extent practicable, prelaunch system-level inspections and tests shall be conducted to verify by end-to-end testing that each critical path in the launch system and the satellite is satisfactory.

TRD4.2.2-2
Whether electrical, mechanical, or both, all critical paths or circuits shall be verified from the application of the initiating signal through completion of each event. This testing is intended to verify that an event command or signal was generated properly and sent on time, that it arrived at its correct destination, that no other function was performed, and that the signal was not present other than when programmed. Once successfully accomplished, that particular critical path or circuit is considered validated. Not all end-to-end tests can be performed with only flight hardware, as in the case in which an explosive event is involved. In cases in which end-to-end testing cannot be performed with the flight hardware and software, appropriate simulation devices should be used to exercise the flight hardware and software to the maximum extent possible. Simulation devices should be controlled carefully and should be permitted only when there is no feasible alternative for conducting the test. All of the events that occur during the mission profile should be tested in the flight sequence to the extent that is practical. Redundant components and subsystems also should be validated in the same manner.

4.2.2.1 Satellite Prelaunch Validation Tests.

TRD4.2.2.1-1
Pre-launch validation tests shall be conducted on space equipment in accordance with the applicable requirements of MIL-STD-1540C for all operational satellites to assure that there are no out-of-tolerance conditions or anomalous behavior.

TRD4.2.2.1-2
The satellite shall be operated through a simulated sequence of ascent phase, separation and engine ignition phase, orbital injection, on-orbit operation and, if applicable, recovery phase.

TRD4.2.2.1-3
These integrated System tests shall include all tests designed to verify System performance.

4.2.2.1.1 Functional Integration.

TRD4.2.2.1.1-1
End-to-end integration tests shall be conducted to assure an orderly buildup and verify proper subsystem operation.

4.2.2.1.2 Alignment Checks.

TRD4.2.2.1.2-1
Alignment checks shall be conducted as required to verify alignments of specific equipment.

4.2.2.1.3 Integrated System Tests.

Integrated System tests are system-level functional tests conducted in accordance with the applicable paragraphs of MIL-STD-1540C.

TRD4.2.2.1.3-1
Integrated System tests shall include a flight simulation encompassing prelaunch, launch, and orbital modes of operation.

4.2.2.1.4 Mass Properties.

TRD4.2.2.1.4-1
Actual weight, moment of inertia, and center-of-gravity (cg) measurements shall be made at the CI level, for sensors, and at the S/C subsystem level to verify predictions and to ensure that the installed equipment meets final weight, moment of inertia, and cg requirements.

4.2.2.1.5Propulsion Subsystem Leakage and Functional Tests.

TRD4.2.2.1.5-1
Functional tests of the vehicle propulsion subsystem(s) shall be conducted to verify the proper operation of all units, to the maximum extent practicable.

TRD4.2.2.1.5-2
Propulsion subsystem leakage rates shall be verified to be within allowable limits..4.2.2.2 Launch System Prelaunch Validation Tests.

TRD4.2.2.2-1
Pre-launch validation tests shall be conducted on the launch vehicle in accordance with the applicable requirements. These integrated System tests include all tests designed to verify System and launch conductor performance.

4.2.2.3 System Prelaunch Validation Tests.

TRD4.2.2.3-1
Prior to launch the prelaunch validation tests shall be conducted on the system (Space, C3 and IDP)in accordance with the applicable requirements. These integrated System tests include all tests designed to verify System and operator performance.

4.2.2.4 Certification for Flight.

Upon completion of the integrated System tests, the test history of the integrated equipment will be reviewed to determine its acceptability for flight. The concept of product flight accreditation is used to assure that the critical components satisfy all requirements that have been found necessary for successful space missions. Unless specifically excluded, flight accreditation should incorporate all technical assessment activity from inception of the program through manufacturing, qualification, transportation, handling, storage, and post-delivery operations leading to final installation and checkout prior to flight. The assessment activity involves incremental reviews and culminates in documentation that all accreditation requirements have been met. After completion of the final review for each item, the acceptability or nonacceptability for flight is documented.

4.3 VERIFICATION CROSS REFERENCE

4.3.1 Verification Methods

TRD4.3.1-1
To demonstrate compliance with the requirements of Section 3 and 5, the System shall be subjected to the cross reference verification matrix Table *(TBS)*.

TRD 4.3.1-1
Methods of verification shall be selected from the following:

a. Inspection. An observation or examination of the item against the applicable documentation to confirm compliance with requirements.

b. Analysis. A process used in lieu of or in addition to testing to verify compliance with specifications. The techniques typically include an interpretation or interpolation/extrapolation of analytical or empirical data under defined conditions or reasoning to show theoretical compliance with stated requirements.

c. Demonstration. An exhibition of the operability or supportability of an item under intended service-use conditions. These verifications are usually non-repetitive and are oriented almost exclusively toward acquisition of qualitative data. Demonstrations may be accomplished by computer simulation.

d. Test. An action by which the operability, supportability, performance capability or other specified qualities of an item are verified when subjected to controlled conditions that are real or simulated. These verifications may require use of special test equipment and instrumentation to obtain quantitative data for analysis as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control.

e. Similarity. Similarity is the process of comparing a current item with a previous item, taking into consideration configuration, test data, application and/or environment. The evaluation should be documented and shall include: the test procedures/reports of the item to which similarity is claimed; a description of the difference(s) between the items; and the rationale for verification by similarity. All in orbit experience should be documented and available for review.

f. Not Applicable. Use of the term "Not Applicable" shall be limited to those paragraph/paragraph headings for which there is no method of verification or where verification is accomplished in subparagraphs.

4.3.2 Formal Qualification

TRD4.3.2-1
Requirements of Sections 3 and 5 shall be verified by the methods specified for each requirement as shown in the Verification Cross Reference Matrix.

5. PREPARATION FOR DELIVERY

5.1 PRESERVATION AND PACKAGING

TRD5.1-1
Deliverable items shall be packed and handled in such a manner as to protect them against vibrations, shocks, moisture, and contamination associated with ground or air transport.

TRD5.1-2
Protection shall be provided against natural environmental conditions using containers, shrouds, or covers.

TRD5.1-3
Access provisions for inspection and handling shall be incorporated for all deliverable items.

TRD5.1-4
A positive means to verify compliance with shock, temperature, and moisture requirements shall be included with all deliverable items.

5.2 MARKINGS

Deliverable units should be marked in accordance with MIL-STD-129K as appropriate for the item being prepared.

6. NOTES

6.1 INTENDED USE

The System is intended for use in the National Polar-orbiting Operational Environmental Satellite System to support worldwide DOD and civilian operations.

6.1.1 Threat

The threats to NPOESS are discussed in the following classified references: Space Systems Threat Environment Description (TED), S/NF/FRD, DOC NAIC-1571-727-95, 11 Sep 95, and the Defense Meteorological Satellite Program (DMSP) /National Polar-Orbiting Operational Satellite System (NPOESS) System Threat Assessment Report (STAR), Secret, NAIC-1571-0110-96, Mar 96. NPOESS survivability requirements are contained in the classified Appendix B of this document.6.1.2 Operational Threat Environment
See DMSP/NPOESS STAR for details on countries that have the capability, or potential capability to threaten NPOESS, and how NPOESS would be threatened under the Major Regional Contingency (MRC)-East (Middle East) and MRC-West (Korean peninsula) scenarios.

6.1.3 System Specific Threats at Initial Operational Capability (IOC) and IOC+10 years

The most likely threats against NPOESS fall into four main categories. The first is Information Warfare (IW), which encompasses network vulnerabilities, Electronic Warfare (EW), and exoatmospheric nuclear bursts. The second is the threat from anti-satellite (ASAT) directed energy weapons (DEWs), to include lasers, radio frequency weapons, and neutral particle beam weapons. The third is the threat from ASAT kinetic energy weapons (KEWs). The fourth is the threat to NPOESS terminal control segments from conventional, unconventional, and non-military forces. See DMSP/NPOESS STAR for details.

6.1.4 Reactive Threat

The reactive threat is an assessment of changes to the threat environment that could reasonably be expected to occur as a direct result of the development and deployment of NPOESS. No reactive threats are anticipated. See DMSP/NPOESS STAR for an explanation.

APPENDIX A
DEFINITION/GLOSSARY OF TERMS

10.1 The following definitions apply to this specification and its appendices.

Airglow

A natural electromagnetic radiation arising from chemical reactions of upper atmospheric constituents. Airglow occurs as emission continua, atomic lines, and molecular bands, with the brightest contributions arising from atomic oxygen and OH. Airglow extends from the ultraviolet, through visible, to the SWIR spectrum, occurs in the 70-300 km altitude range, and is both temporally and spatially variable.

Albedo (Surface)

The ratio of the solar electromagnetic power in a specified band reflected from a surface element of the earth to the total in-band power incident upon it.

Ancillary Data

Any data which is not produced by the NPOESS System, but which NPOESS EDR algorithms require to meet the EDR attributes given in Appendix D (e.g. terrain height data base or conventional surface and upper air observations).

API (Antecedent Precipitation Index)

An estimate of surface moisture based on rainfall history. API includes both surface water and soil moisture. Soil moisture (columnar %) may be computed from API by dividing API by the depth of the soil (in mm), to yield the equivalent vertical mm of water per unit vertical mm depth of soil. Soil moisture (% by weight) may be computed from API by dividing API by the soil bulk density (requires knowledge of soil type).

Argos

A satellite-based location and data collection system dedicated to monitoring the environment.

Centrals

Elements of the NPOESS System which are designated data processing centers. For example, NOAA/NESDIS.

Centrals Element

The Centrals element will be that equipment and software necessary to ingest and store (temporarily) the RDRs, and process them as necessary into SDRs and EDRs. The currently defined Centrals are AFGWC, NOAA/NESDIS, FNMOC, NAVOCEANO, and 50 WS.

Cloud

An aggregate of minute non-precipitating water and/or ice particles in the atmosphere above the earth's surface. In this TRD “cloud” is always to be interpreted to mean “detectable cloud”, as defined in this glossary.

Cloud cover

The fraction of a given area that is overlaid in the local normal direction by clouds. It is the fraction of the earth's horizontal surface that is masked by the vertical projection of clouds.

Cloud type

The classification of clouds into the 18 types given in Tables 3-19 and 3-20 of the Federal Meteorological Handbook 1B.

Common Support Equipment (CSE)

Support equipment capable of common use by various systems throughout DOD, NOAA, and NASA, as applicable.

Communications Security (COMSEC)

Measures taken to provide protection for the transmission of classified and sensitive unclassified information.

Computer Security (COMPUSEC)

Measures taken to provide protection for the processing of classified and sensitive unclassified information.

Critical Failure

Any fault, failure or malfunction which results in the loss of the System's ability to provide any key attribute of a key EDR or other key parameter (e.g. data access).

Design Service Life

The design service life of the satellite is at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency time. It includes the 7 year on-orbit design life and up to 3 years of intermittent testing..

Detectable Cloud

An acqueous aerosol having a vertical extinction optical depth exceeding 0.03 (*TBR*) in the visible or a contrast with the background exceeding 0.02 (*TBR*) in the visible. Contrast with the background is defined as the difference between the cloud and adjacent background radiance divided by the sum of these two radiances. In this TRD "cloud" is always to be interpreted to mean "detectable cloud."

Drop Size Distribution

The number of aerosol, cloud, or rain droplets per specified size interval per unit volume over a specified range of sizes.

Electron Density Profile

The density of free electrons as a function of altitude. It is generally derived from both ionospheric sounding data and theory.

Electronic Counter-Countermeasures (ECCM)

Measures taken to counter electronic warfare susceptibility and vulnerability of a specific system.

Environmental Data

Environmental data (also termed "mission data") refers to all data, atmospheric, oceanographic, terrestrial, space environmental, and climatic, being sensed and collected by the satellite or derived, at least in part, from these measurements.

Environmental Data Records (EDRs)

Data records that contain the environmental parameters or imagery required to be generated as user products by this TRD as well as any ancillary data required to identify or interpret these parameters or images. EDRs are generally produced by applying an appropriate set of algorithms to Raw Data Records (RDRs)

Field Terminals

DoD tactical field element terminals such as the AN/SMQ-11 and TESS used by the USN; the Mark IV used by the USMC and AF; and the Mark IVB and STT used by the AF and any identified follow-on terminals..

Final Operational Capability

The System final operational capability (FOC) will be met when: a full NPOESS satellite constellation meeting all contractual system requirements is operational; sufficient C3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C3S, data recovery, and IDPS operations; and approval to operate at Falcon AFB is received.

Full Mission Capability.

The full mission capability exists when: a full satellite constellation is operational (currently anticipated to be two US and one METOP); sufficient C3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C3, data recovery, and the IDP segment; and approval to operate at Falcon AFB is received.

Geoid

The gravitational equipotential surface corresponding to mean sea level.

Geomagnetic Field

The magnetic field of the Earth.

Global Coverage

Global coverage denotes the observation of all points on the Earth or its atmosphere at least once per given time period (consistent with observational requirements), and implies use of recorded data.

Global Resolution

The horizontal spatial resolution (or cell size) required by Centrals to support global coverage EDRs (see Appendix D).

High Data Rate

Refers to the real time data link to field terminals which contains data at all channels at the smallest scale horizontal spatial resolution (or cell size) required in Appendix D. Note that the smallest scale horizontal spatial resolution (or cell size) is the same resolution as the “regional resolution” required by the Centrals.

Horizon

The actual lower boundary of the observed sky or upper outline of terrestrial objects including nearby natural obstructions.

Horizontal Cell Size

For a parameter which is an estimate of the uniform spatial average of an environmental parameter over a square region of the earth's surface or within a square layer of the atmosphere, the side length of this square region or layer. (For a parameter which is an estimate of an environmental parameter at a point, the horizontal cell size is defined to be zero.) For a reported parameter not of this type but which is defined for a square region of the earth's surface or a square layer of the atmosphere (e.g., cloud cover, ice concentration, etc.), the side length of this square region.

Horizontal Coverage

The horizontal spatial extent of the region within which estimates of an environmental parameter are made and reported.

Horizontal Reporting Interval

The spacing between nearest neighbor points in the horizontal direction at which an environmental parameter is estimated and reported. For atmospheric profiles the horizontal reporting interval applies to the lowest altitude samples.

Horizontal Spatial Resolution

For a scanning imager on a space-based platform, a specified band, and a specified nadir angle, one half of the wavelength corresponding to the earth surface spatial frequency at which the end-to-end system modulation transfer function (MTF) equals 0.5 on the in-track spatial frequency axis or cross-track spatial frequency axis, whichever is greater. The in-track (cross-track) spatial frequency is the earth surface spatial frequency associated with the in-track (cross-track) direction. (See definition of Modulation Transfer Function.)

Horizontal Wind Vector Accuracy

The wind speed error is $| |W_m| - |W_t| |$ where W_m is the measured velocity and W_t is the true velocity. The wind direction error is the angular difference between the directions of W_m and W_t.

Housekeeping

Functions such as orbit and attitude maintenance, navigation, power, command, telemetry and data handling, structure, rigidity, alignment, heater power, temperature measurements, etc..

Imagery

Two-dimensional array of numbers, in digital format, each representing the brightness of a small elemental area.

Initial Operating Capability

IOC has been met when: two satellites are operational; sufficient C3 and mission data recovery resources are available to allow all mission data to be processed at all centrals and 50 percent of field terminals; sufficient crews are trained to allow 24 hours/day, 365 days/year operations at the primary SOC, and to allow backup operations as needed; sufficient sustaining engineering resources are in place to allow for anomaly resolution, for example; sufficient logistics resources are in place to support C3, data recovery, and the IDP segment; and approval to operate at Falcon AFB is received.

Insolation

The solar radiation flux at the surface of the earth.

Ionospheric Scintillation

The random fluctuation of the amplitude and phase of a radio-frequency signal caused by passing through the ionosphere.

Key Attribute

An EDR attribute that is a key parameter of the system. See Key Parameter.

Key EDR

An EDR which has a key attribute. See Key Attribute.

Key Sensor

A sensor which is required to meet key parameter requirements.

Key Parameter

A parameter so significant that failure to meet the threshold requirement(s) pertaining to its measurement is cause for the System to be reevaluated or the program to be reassessed or terminated. Key parameters include key attributes of key EDRs and the data access requirement. Key parameter requirements are to be included in the Acquisition Program Baseline. (The term "Key Performance Parameter" is used in the IORD.)

Lead

Any fracture or passageway through sea ice which is navigable by surface vessels.

Line Replaceable Unit

The smallest unit that can be removed and replaced without cutting or desoldering connections.

Local Average Revisit Time

The average time interval between consecutive measurements of a parameter at a given location on the earth's surface over a time period much greater than an orbital period. Local average revisit time so defined is a function of location on the earth's surface.

Local Refresh

The maximum time interval between consecutive measurements of a parameter at a given location on the earth's surface over a time period much greater than an orbital period. Local refresh so defined is a function of location on the earth's surface.

Local Revisit Time

The time interval between consecutive measurements of a parameter at a given location on the earth's surface. In general, successive revisit times at the same location will not be equal, and the distributions of revisit times during a given period of time at different locations will be different.

Local Time Range

For an in-situ/in-track measurement, range or ranges of ascending/descending times within which NPOESS spacecraft should be capable of measuring an EDR. Measurements outside of the specified range or ranges are not required.

Long Term Stability *(TBR)*

The maximum excursion over the NPOESS life cycle of the short-term average measured value of a parameter when the parameter has essentially the same true value. The short-term average is the average of a sufficient number of successive measurements of the parameter such that the random error is negligible relative to the systematic error and the true value of the parameter is essentially the same when these measurements are performed. The true values of a parameter are considered to be essentially the same for a set of measurements if the standard deviation of the true values is negligible compared to the systematic error. Corrections for known temporal changes in sensor performance characteristics are considered to be part of the measurement and derivation process.

Longwave Radiation

The radiation that is emitted by the Earth or the atmosphere. It is generally in the spectral wavelength interval between 4 and 50 micrometers.

Low Data Rate

Refers to real time data link to field terminals containing fewer channels and/or coarser resolution than the high data rate real time link .

Mapping Uncertainty

The RMS error (one sigma) in the geolocation of measured or derived data samples expressed in geodetic coordinates based on a large number of repetitions of the measurement and/or derivation. An “error” is defined as the difference between the measured or derived value and the true value of a parameter. Mapping uncertainty is due to the combined effect of all systematic and random errors affecting geolocation.

Maximum Local Average Revisit Time

The maximum value of local average revisit time over the set of all locations within a given area of the earth’s surface. Unless otherwise specified, the area is defined to be the horizontal coverage region of the measured parameter. Where constraints on the area are specified, e.g., “clear”, “cloudy”, etc., the area is defined to be the sub-region of the horizontal coverage region satisfying the constraint.

Maximum Local Refresh

The maximum value of local refresh over the set of all locations within a given area of the earth’s surface. Unless otherwise specified, the area is defined to be the horizontal coverage region of the measured parameter. Where constraints on the area are specified, e.g., “clear”, “cloudy”, etc., the area is defined to be the sub-region of the horizontal coverage region satisfying the constraint.

Mean Down Time (MDT)

Mean down time (MDT) is calculated as:

$$\text{MDT} = \frac{\text{total time down from downing events}}{\text{number of downing events}}$$

Mean Time Between Critical Failure (MTBCF)

The total amount of mission time divided by the total number of critical failures during a stated series of missions.

Mean time between critical failure (MTBCF) is calculated as:

$$\text{MTBCF} = \frac{\text{operating time}}{\text{number of critical failures}}$$

Mean Time Between Downing Events

Mean time between downing events (MTBDE) is calculated as:

$$\text{MTBDE} = \frac{\text{operating time}}{\text{number of downing events}}$$

Mean Time Between Failures (MTBF)

The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

Mean Time To Repair (MTTR)

The sum of corrective maintenance times at any specific level of repair divided by the total number of failures within an item repaired at that level during a particular interval under stated conditions.

Mean Time To Restore Functions (MTTRF)

Mean time to restore functions (MTTRF) is calculated as:

$$\text{MTTRF} = \frac{\text{total time down from critical failures}}{\text{number of critical failures}}$$

Measurement Accuracy

The magnitude of the difference between the mean value of a measured or derived parameter and its true value. The mean value is based on a representative ensemble of measurements for which the true value of the parameter is approximately the same and for which the number of measurements is large enough so that the sample size error in the measurement accuracy is negligible compared to the specified measurement accuracy value. An ensemble of measurements is representative if the physical conditions occurring when the measurements are performed span the range of conditions which typically occur in nature and if these conditions have approximately the same relative frequency of occurrence within the ensemble as they do in nature.

Measurement Precision

The standard deviation (one sigma) of a measured or derived parameter based on a representative ensemble of measurements for which the true value of the parameter is approximately the same and for which the number of measurements is large enough so that the sample size error in the standard deviation is negligible compared to the specified measurement precision value. An ensemble of measurements is representative if the physical conditions occurring when the measurements are performed span the range of conditions which typically occur in nature and if these conditions have approximately the same relative frequency of occurrence within the ensemble as they do in nature.

Measurement Range

Range of values over which a parameter is to be measured while meeting all other measurement requirements.

Measurement Uncertainty

The RMS of the errors (one sigma) in a measured or derived parameter based on a representative ensemble of measurements for which the true value of the parameter is approximately the same and which is large enough so that the sample size error in the RMS value is negligible compared to the specified measurement uncertainty value. "Error" is defined as the difference between the measured or derived value and the true value of a parameter. An ensemble of measurements is representative if the physical conditions occurring when the measurements are performed span the range of conditions which typically occur in nature and if these conditions have approximately the same relative frequency of occurrence within the ensemble as they do in nature. As defined herein, measurement uncertainty is due to the combined effects of all systematic and random errors and is equal to the RSS of the measurement accuracy and the precision in the limit of infinitely large ensembles of measurements.

Mesh

A rectilinear (square) grid of lines which is superimposed upon a standard map projection. Current practice is to use a polar stereographic map projection for which each hemisphere is overlaid with a 512 x 512 square grid (called "eighth-mesh"), which is true at 60 degrees latitude, i.e., the quoted geographical grid size of the mesh (25 nmi) is true at 60 degrees latitude. A future upgrade would be the implementation of a sixteenth-mesh ("20 km") grid. (“Mesh” defined fields are also displayable as Mercator projection products)

Meteorological Range (Rm)

An empirically consistent measure of the visual range of a target. It is defined as the distance at which optical intensity is diminished by 17 dB (or the transmittance is 0.02). Meteorological Range Ê**(Rm)** =Ê3.912/a_o, where a_o is the extinction coefficient. The extinction coefficient is defined by: I(x) = I(0) e^{-x/a_o}, where I(x) is the optical intensity at distance x.

Mid-latitudes

The set of all locations on the earth's surface between 20 and 50 degrees north latitude and between 20 and 50 degrees south latitude.

Mission Data

The combination of data provided by any of the mission sensors (i.e., environmental data) plus satellite orbit, attitude, and time tags. It does not include other sensors (i.e., S&R, SDC) or telemetry.

Mission Sensors

Any sensor on the spacecraft directly used to satisfy any of the EDR requirements of Appendix D.

Mixing Ratio

In a sample of moist air, the mixing ratio is the ratio of the mass of water vapor to to the mass of dry air. It is expressed in parts per thousand, usually grams of water vapor per kilograms of dry air.

Modulation Transfer Function (MTF)

The magnitude of the Fourier transform of the end-to-end system point spread function (PSF).). The MTF is a function of two spatial frequencies associated with two orthogonal spatial directions, and is equal to one at the origin by virtue of the normalization condition on the PSF.

Nephanalysis

Analysis of cloud cover in terms of type and amount.

Objective

A requirement which is significantly more difficult to meet than the threshold requirement but which, if met, would greatly enhance the utility of the data to the users.

On Orbit Design Life

The seven year period during which the satellite must meet all operational requirements.

Operational Availability

Operational Availability (A_O) is defined as the probability that a system is operable and ready to perform its mission at any given time. A_O is a function of mean time between critical failure (MTBCF) and mean time to restore functions (MTTRF) and shall be calculated as:

$$Ao = \frac{MTBCF}{MTBCF + MTTRF}$$

Operational Service Life

The period of time that the NPOESS system has to be fully operational after IOC.

Operations Security (OPSEC)

Actions taken or plans developed to protect information, classified or unclassified, which could reveal system plans, procedures, or missions.

Particle Size

The Angstrom wavelength exponent, alpha, defined as:
a = **-**Æln (tau)/Æln (lambda)
where tau is optical thickness and lambda is wavelength.

Payload

Used to refer to the combination of the of the mission sensors and the SDC and S&R sensors carried by the spacecraft . The term may also be used to refer to the satellite when it is still mated to the launch vehicle.**Point Spread Function (PSF)**

See System Point Spread Function.

Precipitable Water Content

The total amount of water and ice contained in a vertical column of the atmosphere.

Primary EDR

EDR for which a sensor contractor has been assigned primary sensor and algorithm development responsibility, either under all conditions or prescribed conditions (e.g., clear versus cloudy conditions). The algorithm may or may not require the use of additional data from other sensors for which the EDR is not primary.

Radiance Reference Levels

In the reference 0.4 - 1.0 µm bandpass, an overhead sun at nadir produces a radiance of 2.65×10^{-2} W/cm^2-sr at the location of the satellite for an earth surface albedo of unity; the radiance is 5.7×10^{-4} W/cm^2-sr when the terminator is at nadir.

Raw Data Records (RDRs)

Full resolution, unprocessed digital sensor data, time-referenced and earthlocated (or orbit-located for in-situ measurements), with radiometric and geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data should be unprocessed with the following exceptions: time delay and integration (TDI), detector array non-uniformity correction (i.e., offset and responsivity equalization), and lossless data compression are allowed. All calibration data will be retained and communicated to the ground without lossy compression. Note that for the real time transmission of raw data to field terminals, lossy compression is allowed. Addtionally, reduced resolution is allowed in transmission of raw data to low data rate field terminals.

Regional Resolution

The smallest scale horizontal spatial resolution (or cell size) defined in Appendix D required by Centrals over specified regions. These regions might not be contiguous. . Note that data at “regional resolution” is also transmitted to high data rate field terminals.

Reporting Frequency

The mean time between successive reports of an EDR. Where reporting frequency is specified "per orbit" or "per satellite", it is the mean time between successive reports of an EDR based on measurements from a single satellite. (Reporting frequency applies to EDR parameters that are not associated with localized portions of the earth's surface or a column of the atmosphere, e.g., in situ measurements, solar irradiance measurements, etc. The times between consecutive observations of a parameter associated with a localized portion of the earth's surface or a column of the atmosphere are described by a constellation dependent distribution which varies from place to place. The attributes "maximum local average revisit time" and "maximum local refresh", which are defined in terms of these earth location dependent distributions, are used for these EDR parameters.)

Satellite

The spacecraft and its sensor payload.

Significant Wave Height

The mean of the highest one-third of the waves observed.

Sea Ice Properties

Ice properties of the polar regions, including concentration, thickness, age, lead concentration, polynya concentration, iceberg distribution, etc.

Sea Surface Topography

The height of the sea surface relative to the center of mass of the earth.

Secondary EDR

EDR for which a sensor may provide data as a secondary input to an EDR algorithm assigned as a primary EDR to another sensor contractor, either under all conditions or prescribed conditions (e.g., clear versus cloudy conditions).

Secondary Mission Capability

The secondary mission capability is provided when mission sensors other than the Imager and Profiler Suites are capable of delivering their RDRs to the C3S and IDPS as required.

Sensor

The mission-peculiar equipment or instrument to be manifested on a given space mission.

Sensor Data Records (SDRs)

Full resolution sensor data that are time referenced, earthlocated (or orbit-located for in-situ measurements), and calibrated by applying the ancillary information including radiometric and geometric calibration coefficients and georeferencing parameters such as platform ephemeris. These data are processed to sensor units (e.g. radar backscatter cross section, brightness temperature, radiance, etc.). Calibration, ephemeris, and any other ancilliary data necessary to convert the sensor units back to sensor raw data (counts) are included.

Sensor Suite
One or more sensors needed to satisfy the EDR requirements allocated to a given Sensor Requirements Document (SRD). It does not include sensors from other SRD suites which provide secondary data contributions to those EDRs.

Short Term Stability *(TBR)*

Shortwave Radiation

The solar radiation that is reflected back by the Earth and the atmosphere. It is generally in the spectral wavelength interval between 0.3 and 4 micrometers.

Significant Wave Height

The height of a fictitious wave whose height and period are equal to the average height and period of the largest one-third of the actual waves that pass a fixed point in some time period.

Soil Moisture

Moisture in the soil within the zone of aeration in cm/m (cm of water per meter of soil depth), including water vapor present in soil pores.

Spacecraft

The components and subsystems which support the sensor(s) and provide housekeeping functions such as orbit and attitude maintenance, navigation, power, command, telemetry and data handling, structure, rigidity, alignment, heater power, temperature measurements, etc..

Space Segment

The satellites (i.e., the spacecraft and their sensors) and their support equipment.

Spectral Index

Slope of the irregularity power spectrum of the electron energy density between two inverse scale lengths.

System Point Spread Function (PSF)

The end-to-end system response due to a point source at infinity in a given bandpass. In this TRD the PSF is considered to be a function of distance along the ground in two orthogonal directions. (A point source on the ground is considered to be “at infinity”.) The PSF is normalized so that the two dimensional integral over the two orthogonal distance variables is equal to one. For a linear system, the system PSF can be expressed as a multiple convolution of the PSFs associated with all system components that contribute to the conversion of input radiance to the system output, e.g., the optics, detectors, signal and data processing.

Telemetry

Health and status data of the satellite including command authentication.

Temperature Data Records (TDRs)
Geolocated antenna temperatures derived from microwave sensor data, together with all calibration, ephemeris, and other ancillary data necessary to convert the antenna temperatures back to sensor raw data (counts)

TEMPEST

Short name referring to the investigation, study, and control of compromising emanations from telecommunications and automated information systems equipment.

Threshold

The less stringent of the two requirements imposed on each measured or derived parameter. The more stringent requirement is the ÒobjectiveÓ. (See definition above.) Failure to meet a threshold requirement for a non-key parameter renders the utility of the System questionable, at least to some segment of the user community. Failure to meet a threshold requirement for a key parameter is much more serious and places the entire program at risk. (See definition of Òkey parameterÓ above.)

Tides

The periodic component of the sea surface topography induced by the gravitational interaction between the earth, moon, and sun.

Timeliness

Elapsed time between the initiation of the measurement(s) necessary to generate an estimate of an environmental data characteristic and delivery of the EDR containing the estimate to the user site.

Total Water Content

Total water content has two components:

1) Total columnar cloud liquid water content (CLWC), and
2) Total columnar integrated water vapor (TIWV).

True Value

True value is defined in terms of *(TBR)* ground truth generally accepted in the user community. When the output of the sensor is folded into atmospheric, radiative transfer and other models to produce EDRs, the measurement uncertainity of the EDR need not be traceable to an absolute reference standard e.g. those maintained by the National Institute of Standards and Technology. The proof of meeting the measurement accuracy, precision, and uncertainty have to be accomplished by analysis, laboratory measurements, simulations, and comparisons to ground based observations. The proof should include both sensor characteristics and the processing algorithms.

Unique Support Equipment (PSE)

Support equipment especially designed for use with a specific system and usable only on that system.

Users

The people such as weather forecasters who employ the obtained environmental data.

Vegetation Index

The identification of the predominant vegetation and/or soil type in a given area (see Appendix D for details).

Vertical Cell Size

For a parameter which is an estimate of the uniform spatial average of an environmental parameter within a square layer of the atmosphere, the vertical thickness of this layer. (For a parameter which is an estimate of an environmental parameter at a point, the vertical cell size is defined to be zero.)

Vertical Coverage

The vertical spatial extent of the region within which estimates of an environmental parameter are made and reported.

Vertical Reporting Interval

The spacing between nearest neighbor points along a local vertical at which an environmental parameter is estimated and reported. (This term is referred to as vertical sampling interval in the IORD; the terminology has been changed to avoid misinterpretation as an sensor measurement sampling interval.)

Visible Radiation

The radiation that the human eye senses as part of the process of "seeing". It is generally in the spectral wavelength interval between 0.4 and 0.7 micrometers. The blue end is near 0.4 micrometers and the red end is near 0.7 micrometers.

Wavelength Categories

Visible/Infrared

Visible:	0.4 - 0.7 µm	
NIR:	Near Infrared 0.7 - 1.5 µm	
SWIR:	Short Wave Infrared	1.5 - 3 µm
MWIR:	Medium Wave Infrared	3 - 5 µm
LWIR:	Long Wave Infrared	5 - 50 µm

APPENDIX B
SURVIVABILITY REQUIREMENTS

Appendix B is classified and will be available in hardcopy in the NPOESS contractor libraries located in Silver Springs and Los Angeles after contract award.

APPENDIX C
SENSOR/TEMPERATURE DATA RECORDS FOR IMAGERY

30.1 Imaging Capability: Sounder Frequencies

The following table represents potential sounder frequency ranges that will be displayed as imagery for operational weather forecasting. This table is not exhaustive, but is intended to define a capability of utilizing (microwave) brightness temperatures (SDRs) as imagery. Scan geometry (if other that conical) is to be removed by calculating an equivalent nadir brightness temperature. This table does not imply these frequency ranges must be used in the sensor suites. However, SDR/TDRs should be available in the IDP for display by the user for channels of the selected ranges used in the sensor suites.

Frequency Range (GHz)	Polarization Content
50-65	Mix
110-126	Mix
145-155	Mix
170-196	Mix
210-230	Mix

30.2 Imaging Capability: Imager Frequencies

The following table represents imager frequency ranges that can be displayed as imagery for operational weather forecasting. This table is not exhaustive, but is intended to define a capability of utiizing (microwave) brightness temperatures (SDRs) as imagery in either vertical or horizontal polarizations. A conical scanning geometry is assumed. This table does not imply these frequency ranges must be used in the sensor suites. However, SDR/TDRs should be available in the IDP for display by the user for channels of the selected ranges used in the sensor suites.

Frequency Range (GHz)	Polarization Content
5-8	V,H
9-11	V,H
18-20	V, H
21-23	V
36-38	V, H
84-92	V,H

APPENDIX D
ENVIRONMENTAL DATA RECORD CHARACTERISTICS

40.1 Reserved for System Level EDR requirements (a separate Word Document file)

APPENDIX E
NPOESS EDR/RDR MATRIX

The real-time high data rate link will contain the following mission data *(TBR):*

a) High (regional) resolution visual and IR imagery (with content similar to the current DMSP fine mode and NOAA High Resolution Picture Transmission)
b) Other NPOESS sensor and associated sensor data needed by the HRD field terminals to meet the EDR processing requirements specified in Table E1.
c) Other (TBS) data

The real-time low data rate link will contain the following mission data *(TBR):*

a) A (TBS) subset of real-time visual, visual night and IR imagery (with content similar to the current NOAA Automatic Picture transmission or future Low Resolution Picture Transmission or DMSP's real time data smooth mode)
b) Other NPOESS sensor and associated sensor data needed by the LDR field terminals to meet the EDR processing requirements specified in Table E1.
c) Other (TBS) data

The processing requirements for the Centrals, HDR and LDR processing sites are shown in 50.1 NPOESS EDR/RDR Matrix.

50.1 NPOESS EDR/RDR Matrix. R = RDRs and E = EDRs.

PARAMETER	DoD (NAVY)			DOC			DoD (AF/ARMY)			
	FNMOC	HDR Field	LDR Field	NESDIS	HDR Field	LDR Field	AFGWC	50 WS	HDR Field	LDR Field
KEY ENVIRONMENTAL PARAMETERS										
Atmospheric Vertical Moisture Profile	R/E	R/E		R	R	R	R/E		R/E	R/E
Atmospheric Vertical Temperature Profile	R/E	R/E		R	R	R	R/E		R/E	R/E
Imagery	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Sea Surface Temperature	R/E	R/E		R	R	R	R/E			R/E
Sea Surface Winds	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Soil Moisture	R/E	R/E		R	R	R	R/E		R/E	R/E
ATMOSPHERIC PARAMETERS										
Aerosol Optical Thickness	R/E	R/E	R/E	R			R/E		R/E	R/E
Aerosol Particle Size	R/E	R/E	R/E	R			R/E		R/E	R/E
Ozone Total Column/Profile				R						
Precipitable Water	R/E	R/E		R	R	R	R/E		R/E	R/E
Precipitation Type/Rate	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Pressure (surface/profile)	R/E	R/E	R/E	R			R/E		R/E	R/E
Suspended Matter	R/E	R/E	R/E	R			R/E		R/E	R/E
Total Water Content	R/E	R/E		R			R/E			R/E
CLOUD PARAMETERS										
Cloud Base Height	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Cloud Cover/Layers	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Cloud Effective Particle Size	R/E	R/E		R	R	R	R/E		R/E	R/E
Cloud Ice Water Path				R	R	R	R/E		R/E	R/E
Cloud Liquid Water	R/E	R/E		R	R	R	R/E		R/E	R/E
Cloud Optical Depth/Transmittance	R/E	R/E		R	R	R	R/E		R/E	R/E
Cloud Top Height	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Cloud Top Pressure				R	R	R	R/E		R/E	R/E
Cloud Top Temperature	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
EARTH RADIATION BUDGET PARAMETERS										
Albedo (Surface)	R/E	R/E	R/E	R			R/E			
Downward Longwave Radiation (Surface)	R/E	R/E		R						
Insolation	R/E	R/E		R						
Net Shortwave Radiation (TOA)	R/E			R						
Solar Irradiance	R/E			R						
Total Longwave Radiation (TOA)	R/E			R						
LAND PARAMETERS										
Land Surface Temperature	R/E	R/E		R	R	R	R/E		R/E	R/E
Normalized Differential Vegetation Index (NDVI)				R	R	R				
Snow Cover/Depth	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E
Vegetation/Surface Type	R/E	R/E	R/E	R	R	R	R/E		R/E	R/E

PARAMETER	DoD (NAVY)			DOC			DoD (AF/ARMY)			
	FNMOC	HDR Field	LDR Field	NESDIS	HDR Field	LDR Field	AFGWC	50 WS	HDRD Field	LDR Field
OCEAN/WATER PARAMETERS										
Currents	R/E	R/E	R/E	R						
Fresh Water Ice	R/E	R/E		R	R	R	R/E		R/E	R/E
Fresh Water Ice Motion	R/E	R/E		R	R	R				
Ice Surface Temperature	R/E	R/E		R	R	R	R/E			
Littoral Sediment Transport	R/E	R/E		R						
Net Heat Flux	R/E	R/E		R						
Ocean Color/Chlorophyll	R/E	R/E		R	R	R				
Ocean Wave Characteristics	R/E	R/E		R	R	R				
Sea Ice Age and Sea Ice Motion	R/E	R/E	R/E	R	R	R	R/E			
Sea Surface Height/Topography	R/E	R/E	R/E	R	R	R				
Surface Wind Stress	R/E	R/E		R	R	R				
Turbidity	R/E	R/E	R/E	R						
SPACE ENVIRONMENTAL PARAMETERS										
Auroral Boundary				R				R/E		
Auroral Energy Deposition (Total)				R				R/E		
Auroral Imagery				R				R/E		
Electric Field				R				R/E		
Electron Density Profile/Ionospheric specification				R				R/E		
Geomagnetic Field	R/E	R/E	R/E	R				R/E		
In-Situ Ion Drift Velocity				R				R/E		
In-Situ Plasma Density				R				R/E		
In-Situ Plasma Fluctuations				R				R/E		
In-Situ Plasma Temperature				R				R/E		
Ionospheric Scintillation				R				R/E		
Neutral Density Profiles/Neutral Atmospheric Spec				R				R/E		
Radiation Belt and Low Energy Solar Particles	R/E			R				R/E		
Solar and Galactic Cosmic Ray Particles	R/E			R				R/E		
Solar EUV Flux				R				R/E		
Supra Thermal through Auroral Energy Particles				R				R/E		
Upper Atmospheric Airglow				R				R/E		
OTHER PARAMETERS										
Surface Data Collection				stored	real-time *(TBR)*					
Search and Rescue Data to be available at the 13 S&R Mission Control Centers and 25 S&R Local User Terminals (LUTs)										

APPENDIX F
ACRONYMS and ABBREVATIONS

60.1 The following acronyms and abbreviations apply to this specification and its appendices.

50 WS	50th Weather Squadron
A	Analysis
A_i	Inherent Availability
A_o	Operational Availability
ADACS	Attitude Determination and Control Subsystem
AF	Air Force
AFGWC	Air Force Global Weather Central
AFSC	Air Force Systems Command
AFSCN	Air Force Satellite Control Network
AFSFC	Air Force Space Forecast Center
AFSPC	Air Force Space Command
AGE	Aerospace Ground Equipment
API	Antecedent Precipitation Index
APT	Automatic Picture Transmission
ASE	Airborne Support Equipment
atm	Atmospheres
BIT	Built-In-Test
BITE	Built-In-Test-Equipment
BPSK	Binary Phase-Shift Keying
C	Centigrade
C2	Command and Control
C3	Command, Control, and Communications
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers and Intelligence Systems
C3S	Command, Control, and Communications Segment
CCSDS	Consultative Committee for Space Data Systems
CCSDS-SCPS	Consultative Committee for Space Data Systems Space Communication Protocal Standards
CDA	Command and Data Acquisition
CDHS	Command and Data Handling Subsystem
CI	Configuration Item
CISF	Consolidated Integrated Support Facility
CLWC	Cloud Liquid Water Content
cm	Centimeter
COMPUSEC	Computer Security
COMSAT	Communications Satellite
COMSEC	Communications Security
CONUS	Continental United States
COSPAS	Russian for Space System for Search of Vehicles in Distress
COTS	Commercial Off-the Shelf
CPIN	Computer Program Identification Number
CPU	Central Processing Unit
CSCI	Computer Software Configuration Item
CSOC	Consolidated Space Operations Center
D	Demonstration
D_o	Operational Dependability
DAA	Designated Approving Authority
dB	Decibels
DBMS	Data Base Management System
deg	Degrees
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DoD	Department of Defense

DODI	Department of Defense Instruction
DRR	Data Routing and Retrieval
ECCM	Electronic Counter Counter Measures
EDAC	Error Detection and Correction
EDR	Environmental Data Record
EIRP	Effective Isotropic Radiated Power
ELSET	Element Set
ELT	Emergency Location Transmitter
EMC	Electromagnetic Compatibility
E-O	Electro-Optic
EPCRA	Emergency Planning and Community Right to Know Act
EPS	Electrical Power Subsystem
ESA	European Space Agency
ESOC	Environmental Satellite Operations Center at Falcon AFB, Co.
EST	Equipment Status Telemetry
EUMETSAT	European Meteorological Satellite
eV	Electron Volts
FNMOC	Fleet Numerical Meteorology & Oceanography Center
FOC	Final Operational Capability
FOT&E	Final Operational Test and Evaluation
FOV	Field of View
FVS	Flight Vehicle Simulator
GFE	Government Furnished Equipment
g	Gram
gm	Gram
GOTS	Government Off The Shelf
GPS	Global Positioning System
GSE	Ground Support Equipment
GUI	Graphical User Interface
hrs	Hours
HUMINT	Human Intelligence
I	Inspection
IDP	Interface Data Processor
IDPS	Interface Data Processor Segment
I/O	Input/Output
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IPO	Integrated Program Office
IR	Infrared
IRD	Interface Requirements Document
ISC HCI	Integrated Satellite Control Human Computer Interface
K	Kelvin
Kbps	Kilo (10^3) bits per second
Kev	Kilo-electron Volts
kg	Kilogram
km	Kilometer
kR	Kilo Rayleighs
LLTIL	Long Lead Time Items List
LOS	Loss of Signal
LRU	Line Replaceable Unit

LSA	Logistics Support Analysis
LSS	Launch Support Segment
LST	Local Solar Time
LUT	Local User Terminal
LV	Launch Vehicle
m	Meters
m/s	Meters Per Second
mb	Millibar
Mbps	Mega (10^6) bits per second
MDI	Multi-Disciplinary Intelligence
MDT	Mean Down Time
ME	Mission Effectiveness
METOP	Meteorological Operational
MeV	Mega-electron Volts
MHz	Mega (10^6) Hertz (cycles per sec)
µg	Micro (10^{-6})-gram
µm	Micro (10^{-6})-meter
mm	Milli (10^{-3})-meter
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
min	Minutes
MMD	Mean Mission Duration
msec	Milli-seconds
MTBCF	Mean Time Between Critical Failures
MTBDE	Mean Time Between Downing Events
MTTRF	Mean Time To Restore Function
mV	Milli-volt
N/A	Not Applicable
NASA JSC	National Aeronautics and Astronautics Administration Johnson Space Center
NATO	North Atlantic Treaty Organization
NAVOCEANO	U.S. Naval Oceanographic Office
NBC	Nuclear, Biological, and Chemical
NCA	National Command Authority
NESDIS	National Environmental Satellite, Data, and Information Service
nm	Nano (10^{-9}) meters
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRZ	Not Return to Zero
NSA	National Security Agency
nT	Nano-Tesla
NTIA	National Telecommunications and Information Administration
OPSEC	Operations Security
ORD	Operational Requirements Document
PMPCB	Parts Material Process Control Board
PHS&T	Packaging, Handling, Storage, and Transportation
POES	Polar-orbiting Operational Environmental Satellite
ppbv	Parts Per Billion By Volume
PPL	Provisioning Parts List
PS	Propulsion Subsystem
PTT	Platform Transmitter Terminals

QPSK	Quadriphase Phase-Shift Keying
R	Rayleighs
RDR	Raw Data Record
RF	Radio Frequency
RH	Relative Humidity
RHCP	Right Hand Circular Polarized
RM&A	Reliability, Maintainability, and Availability
RMS	Root Mean Square
RPIE	Real Property Installed Equipment
RSS	Root Sum of Squares
RTS	Remote Tracking Station
s	Second
S	Similarity
SAIP	Spares Acquisition In conjunction with Production
SARP	Search and Rescue Processor
SARSAT	Search And Rescue Satellite Aided Tracking
S&R	Search & Rescue
SCA	Satellite Control Authority
SDC	Surface Data Collection
sec	Seconds
SEP	Spherical Error Probable
SERD	Support Equipment Recommendation Data
SES	Space Environmental Suite
Sfc	Surface
SFC	Space Forecast Center
SI	International System of Units (Metric)
SMD	Stored Mission Data
SMS	Structures and Mechanisms Subsystem
SOC	Satellite Operations Center
SOCC	Satellite Operations Control Center (Suitland, MD.)
SQPSK	Staggered Quadriphase Phase-Shift Keying
sr	Steradian
SRD	Sensor Requirement Document
SS	Space Segment
STAR	System Threat Assessment Report
STDN	Spaceflight Tracking and Data Network
ster	Steradian
STT	Small Tactical Terminal
SWIR	Short Wave Infrared
T	Test
TAC	Telemetry and Command Subsystem
TBD	To Be Determined (by contractor)
TBR	To Be Resolved (by contractor/government)
TBS	To Be Supplied (by government)
TCS	Thermal Control Subsystem
TDRSS	Tracking and Data Relay Satellite System
TEC	Total Electron Content
TED	Threat Environment Description
TESS	Tactical Environmental Support System
TIWV	Total Integrated Water Vapor
TM	Technical Manual
TOA	Top of Atmosphere

UHF	Ultra High Frequency
ULOSA	Unit-Level Open System Architecture Specifications
USAPC	United States Argos Processing Center
USAF	United States Air Force
USG	United States Government
USMC	United States Marine Corps
USMCC	United States Mission Control Center
USN	United States Navy
USSPACOM	United States Space Command
UV	Ultraviolet
VAFB	Vandenberg Air Force Base
W	Watts
WTR	Western Test Range
yr	Year

APPENDIX G
POTENTIAL PRE-PLANNED PRODUCT IMPROVEMENTS

70.1 Potential Pre-planned Product Improvements. This paragraph describes elements of the NPOESS mission needs having potentially restrictive technical or programmatic uncertainties identified as a result of Phase 0 Concept studies. DOC and DoD maintain a need for these observations, and prioritize them in terms of mission criticality below. The NPOESS Demonstration/ Validation (Phase 1) allows for continued examination of possible solutions to these needs, including new or modified instrumentation in future space segments beyond NPOESS IOC. Candidate technologies for meeting these needs should be examined in NPOESS Phase 1 for possible inclusion at a later time. No thresholds are stated.

70.1.1 Tropospheric Winds (DOC/DoD). Wind measured throughout the troposphere. Wind profile required for cloud returns and planetary boundary layer aerosol returns.

	Thresholds	Objectives
a. Vertical Coverage	N/A	surface to 20 km
b. Horizontal Cell Size	N/A	50 km
c. Vertical Sampling Interval	N/A	0.1 km
d. Mapping Uncertainty	N/A	10 km
e. Measurement Range	N/A	0-100 m/s
f. Measurement Precision	N/A	0.5 m/s, vector winds
g. Measurement Accuracy	N/A	1 m/s, horiz. components
h. Maximum Local Average Revisit Time	N/A	1 hour

70.1.2 Ozone Profile - High-Resolution (DOC). Measurement of ozone concentration within a specified volume.

	Thresholds	Objectives
a. Vertical Coverage	N/A	*(TBD)*
b. Horizontal Cell Size (Profile)	N/A	250 km
c. Vertical Cell Size (Profile)		
1. 0-10 km	N/A	3 km
2. 10-25 km	N/A	1 km
3. 25-60 km	N/A	3 km
d. Mapping Uncertainty (Profile)	N/A	25 km
e. Measurement Range (Profile) 1. 0-10 km 2. 10-60 km	 N/A N/A	 0.01-3 ppmv 0.1-15 ppmv
f. Measurement Precision (Profile) 1. 0-10 km 2. 10-15 km 3. 15-50 km 4. 50-60 km	 N/A N/A N/A N/A	 10 % 3 % 1 % 3 %
g. Measurement Accuracy (Profile) 1. 0-10 km: N/A 2. 10-15 km: 20 % 3. 15-60 km: 10 %	 N/A N/A N/A	 10 % 10 % 5 %
h. Maximum Local Average Revisit Time (Profile)	N/A	24 hours
i. Long Term Stability (Profile)	N/A	1 %

70.1.3 CH_4 (Methane) Column (DOC). Measure of amount of methane contained in a specified volume of air.

	Thresholds	Objectives
a. Vertical Coverage	N/A	Total column

b. Horizontal Cell Size	N/A	100 km
c. Mapping Uncertainty	N/A	25 km
d. Measurement Range	N/A	40-80 moles/cm2
e. Measurement Precision	N/A	1 %
f. Measurement Accuracy	N/A	5%
g. Maximum Local Average Revisit Time	N/A	24 hours

70.1.4 CO (Carbon Monoxide) Column (DOC). Measure of carbon monoxide in a specified volume of air.

	Thresholds	Objectives
a. Vertical Coverage	N/A	Total column
b. Horizontal Cell Size	N/A	100 km
c. Mapping Uncertainty	N/A	25 km
d. Measurement Range	N/A	0 - 7 moles/cm2
e. Measurement Precision	N/A	3 %
f. Measurement Accuracy	N/A	5%
g. Maximum Local Average Revisit Time	N/A	24 hours

70.1.5 CO_2 (Carbon Dioxide) Column (DOC). Retrievals of column and total carbon dioxide, calibrated by the users with ground-based measurements, of stated precision needed to afford deduction of long-term variations and trends.

	Thresholds	Objectives
a. Vertical Coverage	N/A	Total column
b. Horizontal Cell Size	N/A	100 km
c. Mapping Uncertainty	N/A	25 km
d. Measurement Range	N/A	11,000 - 15,000 moles/cm2
e. Measurement Precision	N/A	15-20 moles/cm2
f. Measurement Accuracy	N/A	*(TBD)*
g. Maximum Local Average Revisit Time	N/A	24 hours

70.1.6 Optical Backgrounds (DoD). Emissions are the result of interactions between precipitating energetic particles and solar ultraviolet radiation with neutral atmospheric constituents.

	Thresholds	Objectives
a. Coverage	N/A	Global
b. Horizontal Cell Size	N/A	10 km
c. Mapping Uncertainty	N/A	50 km
d. Measurement Range		
1. Wavelength	N/A N/A	1-29 microns, 0.4-0.7 microns, 0.04-0.2 microns
2. Brightness	N/A	*(TBD)*
e. Measurement Precision	N/A	*(TBD)*
f. Measurement Accuracy	N/A	*(TBD)*
g. Maximum Local Average Revisit Time	N/A	each orbit

70.1.7 Bathymetry (Deep Ocean and Near Shore) (DoD). Vertical depth of water.

	Thresholds	Objectives
a. Vertical Coverage		
1. Deep Ocean	N/A	0-300 m

2. Near shore	N/A	0-200 m
b. Horizontal Cell Size		
1. Deep Ocean	N/A	300 m
2. Near shore	N/A	*(TBD)*
c. Vertical Cell Size	N/A	1 m
d. Mapping Uncertainty	N/A	10 m
e. Measurement Range		
1. Deep Ocean	N/A	0-300 m
2. Near shore	N/A	0-200 m
f. Measurement Accuracy	N/A	0.3 m
g. Maximum Local Average Revisit Time	N/A	*(TBD)*

70.1.8 Bioluminescence (DoD). A measurement of the number of bioluminescent organisms present in sea water within a region.

	Thresholds	Objectives
a. Horizontal Cell Size	N/A	*(TBD)*
b. Mapping Uncertainty	N/A	*(TBD)*
c. Measurement Accuracy	N/A	*(TBD)*
d. Maximum Local Average Revisit Time	N/A	*(TBD)*

70.1.9 Salinity (DoD/DoC). A measure of the quantity of dissolved materials in sea water. A formal definition is "the total amount of solid materials, in grams, contained in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all organic matter is completely oxidized. Units of measurement are parts per thousand, by weight."

	Thresholds	Objectives
a. Vertical Coverage	N/A	0-300 m
b. Horizontal Cell Size		
1. Global	N/A	20 km
2. Regional	N/A	0.25 km
c. Vertical Cell Size		
1. Global	N/A	10 m
2. Regional	N/A	2 m
d. Mapping Uncertainty		
1. Global	N/A	5 km
2. Regional	N/A	0.25 km
e. Measurement Range	N/A	0-40 ppt
f. Measurement Precision	N/A	0.1 ppt
g. Measurement Accuracy		
1. Global	N/A	*(TBD)*
2. Regional	N/A	0.5 ppt
h. Maximum Local Average Revisit Time	N/A	72 hours